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ORDNANCE CORPS · DEPARTMENT OF THE ARMY

REDSTONE ARSENAL

HUNTSVILLE, ALABAMA

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HISTORY

OF

ROCKET DEVELOPMENT DIVISION

by

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II INTRODUCTION

A. General Description and Limitations

1. The plan presented is an overall plan for the organization and utilization of manpower, equipment, and facilities to accomplish that portion of the mission of Redstone Arsenal now assigned to the Rocket Development Division of the Ordnance Missile Laboratories. This plan considers all necessary functions required to fulfill the responsibilities of the division. As presented, it is contingent upon obtaining the help, guidance, services and co-operation of the other units of Ordnance Missile Laboratories and the other agencies of Redstone Arsenal to the maximum extent consistent with assigned responsibilities. Effort has been made to retain maximum flexibility without sacrifice of the supervisory authority necessary to consummate complete responsibility. The result is a general plan based on functional organization: the project or product breakdown is used to insure adequate supervision and continuity of projects and programs within this functional framework.

2. This plan is only as general as the currently assigned mission. It contemplates changes in schedules and workload, the completion of assigned projects, the introduction of new projects, and the shifting of emphasis within the framework of the stated mission. It is not intended to be adaptable to major changes in objective. It is not a mobilization or standby operations plan, but is a day to day work plan.

3. Since the division is in the stages of its first growth, in an activity new to the establishment as well as to most of the personnel, efforts have been made to arrive at schedules and growth rate that should result in balanced acquisition of people, equipment and facilities at a rate commensurate with the acquisition of specialized knowledge and experience. Separation of budgetary controls, time lag between budgetary requests and receipt of funds, uncertainties in the time of availability and amount of funds for a specific purpose, difficulties in recruitment of personnel, and controls on employment all tend to make prediction difficult. These uncertainties emphasize the importance of a long range plan adequate to insure the capability of fulfillment of the entire assigned mission at a reasonably close future date. The plan must be flexible enough to meet contingencies arising from an uncertain and changing program yet be sufficiently detailed to take advantage of any opportunity for strengthening the divisions ability to perform its required functions.

4. Separated portions of the overall plan form various sub-plans such as: a plan for acquisition of facilities from the "MCA" budget; a plan for acquisition of equipment from the "Supply Program" budget; a plan for improving facilities by use of "Repairs and Utilities" funds; a plan for acquisition of personnel; a work program; an on-the-job training program; etc. These sub-plans cannot stand alone: they are contingent on a balanced growth of personnel, equipment, facilities and programs. The separation of budgets and budgetary controls must not obscure the mission and the requirement for attaining the assigned objectives as economically as is possible.

B. Basis for Planning

1. Two related statements of purpose form the basic criteria for determining the effectiveness of the Rocket Development Division. Each of these has been stated in many forms depending on the specific order establishing or reiterating policy. They are restated here to give a convenient check list to be used to determine whether each of these important functions may be most efficiently executed with the implements provided by this plan. These statements of purpose are also a criteria to be used to test the desirability of alternative plans or changes to the plan presented. These statements are first, the important functions of an arsenal (herein limited to those applicable to research and development work) and second, the specific mission of this division.

2. The important research and development functions of an arsenal are:

a. To establish and maintain Ordnance leadership in scientific, engineering, production and management activities so the techniques required for rapid development and increase in production of weapons in time of emergency will be available.

b. To insure the continuous research and development required to put superior weapons in the hands of the troops in time of war.

c. To provide the specialized technical knowledge required to initiate, direct, evaluate and supervise the work of contractors in the fields peculiar to weapons technology.

d. To train a nucleus of civilian and military personnel to be available to expand the arsenal activities, and be available to assist industry in time of mobilization.

e. To investigate development trends in allied fields of civilian endeavor, and initiate that research and development required to exploit advances in technology by application of the increase in knowledge to weapons development or production.

f. To take appropriate action to establish special procedures required in the interest of completion of the development and initial production of urgent and critical items.

g. To keep the technology of weapons design and production alive in time of peace.

3. The mission of the Rocket Development Division is:

a. To function as the principal research and development agency of the Ordnance Corps for free rockets, rocket propellants, and jatos.

b. To design, develop, fabricate, and test rockets, jatos, rocket launchers and/or components therefor, as assigned.

c. To maintain close association with scientific, educational and industrial organizations to insure complete cognizance throughout the field.

d. To exercise technical supervision and coordination over Ordnance Corps Research and Development projects as assigned.

4. The statements of purpose reiterated here are of a most general nature; hence, they are so underdefined that they do not indicate a specific organization or plan. Research and Development projects are funded by Research and Development Orders which specify technical objectives. Utilization of Research and Development funds is further limited by requirements established by Ordnance

Committee Action and specified in Ordnance Committee Minutes. This procedure for initiation of activities tends to obscure the basic purposes of the organization; so there exists grave danger that the management may become so absorbed in the details of specific projects that important functions of the basic program are consequently neglected. The danger of neglecting an important function can be minimized by a sound overall plan supplemented by comprehensive planning and careful programming of specific projects. Project plans must be reviewed for compliance with the assigned mission as well as the specified objectives at the time of initiation, and accomplishments must be checked against the schedule and objectives at specific periods. Careful programming and review of projects will indicate compliance with the stated purposes of the division as well as the effectiveness of the work accomplished. Thus the research and development functions of an arsenal, together with the Mission of the Rocket Development Division, and the specific project objectives become the standards by which achievements may be measured.

5. To provide weapons and equipment having improved performance and increased reliability at reasonable or reduced cost, good design, superior propellants, advanced metallurgical and fabrication practices, sound interior ballistics and rational exterior ballistics must be developed and applied. This statement implies the types and qualifications of required personnel, the general kinds of equipment and facilities necessary, as well as the activities of the division. The geography and existing buildings and utilities of Redstone Arsenal account for most of the other factors determining the plan.

III GENERAL BACKGROUND

A. Definitions

1. To avoid confusion in the interpretation and application of the context, some definitions of common terms are presented. The definitions used in this report are not stated to initiate arguments over rigor, philology or semantics, nor speculations about terminology. Recognition of the scope and limits of the defined terms should free the attention of the reader, thus permitting concentration on the formulation of the plan.

a. Rocket Development Division:
The organization which works as a whole to prosecute the complete functions now stated or implied

in the mission of the Rocket Development Division. The limitation is imposed that functions now assigned to other organizational segments will be conducted in a manner which will make undesirable the duplication of these efforts by the Rocket Development Division. The title used for the organization is not important except in so far as it denotes functions. The present functions and scope of work are not identical to those assigned to its predecessors "The Research and Development Division", "The Ordnance Rocket Center", or "The Rocket Development Group of the Technical and Engineering Division". This is a dynamic organization and the title embraces those changes with time which are consistent with the "Basis for Planning" outlined in the "Introduction" of this report. To reiterate, we are using the functional definition of organization as a whole for a specific mission; which cannot be completely presented on an "Organization Chart" or in an "Organization Manual".

b. Research:
The continuous process of scientific investigation to discover and establish new scientific facts, techniques, and physical relationships. Since all research conducted by this division is directed toward the embodiment of new ideas in weapons or other Ordnance materiel, or in the materials, techniques, methods or processes used in production for the purpose of simplifying logistic or tactical problems, no consideration is given to fundamental or basic research. Supporting and applied research are terms which will be indiscriminately used in this report: there is no convenient method of predicting where or when work that starts as one of these classes will culminate as the other.

c. Development:
The application of known facts to the creation of new or improved materiel or methods.

d. Research and Development:
The functions which extend from the inception of ideas to their final embodiment in all types of materiel, or the techniques, methods, processes and materials used for producing materiel. This includes investigations and exploratory studies necessary to establish scientific and technical data before and during development, and to determine the necessity for and feasibility of further research and/or development. It includes actions related to such modifications of materiel as would affect the technique of its employment: it excludes modifications of developed materiel which are simply for expediting production and do not affect the characteristics of interest to the ultimate user.

B. Fundamental Ideas

1. A precept which has not been questioned to date is that major research and development programs will be accomplished by contractors. The concept of contracting for the maximum amount of research and development work with industrial concerns has been supported by statements of policy at Department of Defense and Department of the Army levels as well as by Ordnance Corps Orders and Memoranda. The responsibility for executing all phases of the stated mission in a manner that will fulfill all research and development functions of the arsenal can be consummated using contractors' services to a maximum, provided continuous programming in accordance with a plan that includes all necessary functions is adhered to, and provided that certain specialized services required to supplement the work of the contractors are adequately developed.

2. The Rocket Development Division must supply adequate technical knowledge and ability to supervise and coordinate the research and development work of contractors on projects assigned. This implies sufficient knowledge to: evaluate the research and development work proposed by contractors or prospective contractors; evaluate work accomplished by contractors; recognize the need for and initiate contracts for new work to exploit results of research and development projects assigned; initiate research and development to exploit advances in allied fields.

3. Recruitment of the best available personnel must be reinforced by continuous on the job training of both formal and informal natures. The informal on the job training must be a continuous daily task of all supervisory personnel. The special technical talents and aptitudes of the better professional and technical people must be transmitted to those working at a lower level by planning and assigning tasks in a way that will insure the working contacts required to broaden the outlook, background and experience at every level of employment. Those having technical training must not be permitted to stagnate and fall behind progress in their field of specialization but must be given assignments that will force acquisition of knowledge that will keep them abreast of new developments and encourage original contributions. Ordnance being specialized must train its personnel and replacements in its peculiar specialties.

4. Personnel in a position to affect the work of contractors by supervision, coordination, advice, direction or evaluation must have adequate information, knowledge, background and good judgment to insure the best efforts and optimum results from the work of the contractors: as a minimum requirement, they should have no adverse affects upon his work. The dangers resulting from misdirection, imposition of unnecessary or meaningless tasks and procedures, the imposition of needless controls or limitations are so grave that only the best qualified personnel available should be utilized as project engineers. Project engineers must be selected for or trained to have a thorough knowledge of their limitations, a maturely cooperative approach to their work with the contractors, a knowledge of the best sources of information and advice, and those qualities of personality which will earn the respect and best efforts of the contractor. The personnel carrying on this function must be well schooled in pertinent policy and must understand and scrupulously observe good ethical practices. Since policy has been and is to accomplish the end item producing portion of the assigned work through contractors, it is essential that contacts and representation of the arsenal with the contractors be the most effective possible. It is essential that, using the proper channels, the project engineer demand and receive the maximum help that the arsenal and the Ordnance Corps as a whole can give him.

5. To establish and maintain Ordnance leadership in scientific, engineering, production and management activities

and to insure continuous research and development required to put superior ordnance in the hands of the troops, it is essential that some research and development be continuously conducted by government employees using government facilities at least to the minimum extent required to train personnel in the specialized knowledge required to initiate, direct, evaluate and supervise the work of contractors. Further, in order to be in a position to economically and rapidly expand the number of contractors engaged in weapons development in time of emergency, it appears advisable to erect certain special facilities to be manned by career federal employees. To take appropriate action to establish special procedures required in the interest of completion of the development and initial production of urgent and critical items, personnel trained in research and development techniques together with the proper tools and facilities are required. In the interest of economy of time and personnel this same organization must be available to aid the project engineer and the contractor when unforeseen difficulties or lack of knowledge arise in the course of a project.

C. Facts Leading to Plan

1. Since this report presents one plan for the accomplishment of the mission of the Rocket Development Division, only that portion of the history of the arsenal which is directly pertinent to the formulation of this plan will be presented in this section. A subsequent section is devoted to a more complete history which indicates how and when there were changes in or deviations from this plan, and why this complete plan was not previously presented.

2. In 1948 the decision was made in the Office of the Chief of Ordnance to assign to an arsenal, as its primary mission, research and development activities in the field of rockets, jatos and rocket launchers. At that time the rocket research and development program necessary to produce the weapons required by the Army and Air Force was suffering from delays caused by insufficient personnel and inadequate facilities. The portion of the required work then being accomplished was in progress at the Office of the Chief of Ordnance, ORDTU, Picatinny Arsenal, Rock Island, and Aberdeen Proving Grounds; however, the magnitude of the work being delayed was too great to warrant its concentration at any of those establishments. Study indicated that there were more suitable facilities that could be adapted to the conduct

of rocket research and development work at Redstone Arsenal than at any other government-owned site. Huntsville Arsenal, a class II installation then under the jurisdiction of the Chief, Chemical Corps, with boundaries common to Redstone Arsenal, was in the process of being liquidated. By consolidation of these properties, adequate land would become available for testing and ranges. The location being strategically well removed from the coast lines and available manpower in the vicinity appearing adequate, the decision was made to assign this mission to Redstone Arsenal.

3. At the time of the decision to locate the center for the Department of the Army for all research and development activities in the field of rockets, jatos and rocket launchers at Redstone Arsenal, this installation had approximately 100 people working on the renovation of ammunition, a small group working on Field Service storage and warehousing activities, housekeeping and supporting activities being conducted by the Post Engineers, and the small headquarters force requisite to the administration of these functions. There were no research and development activities at the arsenal. In December 1948 Lt Col Ernest R. Gillespie was transferred to the arsenal and initiated preparations for the activation of research and development work. In November 1948 Col Carroll D. Hudson was assigned as commanding officer. In January of 1949 recruitment of civilian personnel was initiated and in February 1949, the predecessor of the Rocket Development Division was started with Lt Col Gillespie as its Chief. The major effort at this time was the study of grounds and utilities for the purpose of adapting existing buildings and facilities to the newly assigned functions, and to negotiations for acquisition of certain of the properties of Huntsville Arsenal. Efforts were made to recruit technical specialists to serve as advisors to the Commanding Officer and to assist him in his duties as the Contracting Officer.

4. Negotiations were made between the Ordnance Department and Thiokol Corporation of Trenton, New Jersey (now Thiokol Chemical Corporation) to relocate their operations from Elkton, Maryland to Redstone Arsenal. RAD Order ORDTU 9-10932 dated 4 April 1949 allotted $63,774.00 with instructions, quoted in part, as follows: "The purpose of this RAD Order is to furnish funds to cover the initial cost of relocation of the Thiokol plant, laboratory and equipment therein, from its present

site at Elkton, Maryland to Redstone Arsenal, Huntsville, Alabama. This amount includes approximately $36,774.00 for cost incurred by the contractor in movement, and the remaining $27,000.00 is for the cost of installation of the equipment at Redstone Arsenal. These monies will cover the cost of work incurred through August 1949. Additional funds to complete the installation of the equipment will be supplied when FY 50 funds become available." "Technical Supervision: Redstone Arsenal." This move was accomplished by the end of August 1949.

5. Negotiations were made between the Ordnance Department and Rohm & Haas Company of Philadelphia, Pennsylvania to staff and operate a research and development facility at Redstone. RAD Order ORDTU 9-10960, dated 21 April 1949 allotted $100,000.00 with the following instructions: "This RAD Order is for the purpose of furnishing funds for the cost of a contract with Rohm & Haas for the operation of research and development activities on rocket devices at Redstone Arsenal, Huntsville, Alabama. The work will consist of basic and applied research on propellants, fatos, and rockets including operation of the research laboratory and a pilot line for making propellant samples." "Technical Supervision: Redstone Arsenal."

6. Memorandum from Commanding Officer to Chief, Research and Development Division dated 6 April 1949 is quoted in part:

> "1. The primary responsibility of the Research and Development Division is the technical supervision and coordination of research and development contracts pertaining to rockets administered by the Contracting Officer. To accomplish this primary responsibility a suitable training program will be established and a schedule of lectures pertaining to selected subjects will be published."
>
> "3. To further proper discussion and dissemination of current technical information, an organization to be known as The Redstone Technical Society will be established and shall hold regularly scheduled meetings. It is anticipated that lectures, talks, papers and discussions will be at a level of technical competence that will reflect credit

to this command. The use of films and training aids is to be encouraged and assistance will be provided to aid the speakers in every manner possible."

In May 1949 permission was granted to use Building A-120 for a rocket research laboratory. In June 1949 work was started to adapt an existing barricade 200 feet to the rear of Building A-120 for a static test stand. A 2.36" M7 rocket motor was fired on this static stand on 8 August 1949. As of 1 July 1949 there was a total of 23 persons assigned to research and development activities including both military and civil service personnel. Thiokol Corporation employed 12 people at the arsenal and Rohm & Haas had 4. There were still some questions as to what functions would be required in order to fill the assigned mission, and the interpretation of the mission itself was a subject of much discussion.

7. Ordnance Department Order Number 25-49 dated 18 July 1949, titled "Mission of Redstone Arsenal" is quoted in part:

"2-b. Operate facilities for the research and development of rockets and related items."

"4. Research and Development Functions. For the accomplishment of the research and development mission, the Arsenal will:

a. Conduct basic and applied research, development and testing of free rockets, solid propellants, jatos and related items.

b. Conduct static and range firing in connection with this development.

c. Administer research and development contracts placed within the Arsenal, and exercise technical supervision over such projects.

d. Exercise technical supervision and coordination of all Ordnance Department rocket projects as assigned.

e. Keep abreast of all scientific and technological progress and developments in this field outside of the Ordnance Department. Maintain liaison with educational and scientific institutions, industrial establishments and other government agencies having related interests.

f. Serve as the principal source of technical information within the Ordnance Department on this materiel."

8. In August 1949, a group of people from the Office of the Chief of Ordnance, ORDTU were transferred to Redstone. Certain of the activities formerly conducted by ORDTU were transferred along with the personnel. At this time the first plans for organization of Ordnance Rocket Center to conduct those research and development functions contained in Ordnance Department Order Number 25-49 were formulated keeping the organizational pattern close to that of ORDTU in order to better utilize the particular experiences of the people transferred from ORDTU. The Design Group under Mr. C. J. Koeper (present Chief of Design Branch, RDD) was engaged in making design studies, preliminary feasibility studies, evaluations, drafting and preparation of ideas for new designs for purposes of initiation of contracts, writing and reviewing specifications, etc. The functions assigned to this section of the new organization were identical to its previous assignments in ORDTU. Mr. S. W. Swipp, who was a project engineer in ORDTU previous to his transfer, was assigned the task of organizing a project section to coordinate and exercise technical supervision over the work of contractors. Project Officers were assigned to assist the Contracting Officer in the administration and supervision of the work of the two resident contractors: they were specifically assigned "to serve as representative of the Contracting Officer; to assist the contractor in his preparations to accomplish the work agreed upon; to expedite the accomplishment of the tasks specified in the contract; to serve as liaison between contractor and government agencies." Mr. F. W. James (present Chief of Rocket Development Laboratory) was assigned the task of initiating research and test activities, developing instrumentation and laboratory equipment and supplies, and the training of personnel in test, instrumentation, and research work. The technical library became a part of the Ordnance Rocket Center. Internal administration and planning were retained in the Office of the

Chief, Ordnance Rocket Center. New assignments were to be accomplished by gradual development of additional personnel and facilities. Personnel training was to be expedited by progressively rotating the task assignments of the individuals.

9. The site for a range for shoulder fired and short range free flight testing was selected (present Range #2) and work preparatory to firing was started in August 1949. A wiring system was installed, a launching stand was erected, earth barricades were emplaced, and on 20 September 1949, a 2.36-inch T59 Rocket was launched. On 20 October 1949 the first of a series of demonstrations for visiting officials was conducted: this consisted of firing two 2.36-inch T27E1 Rockets with smoke heads. Acquisition of supplies and equipment, erection of barricades and temporary buildings, wiring and installation of equipment continued; actual project assigned and scheduled testing started on 21 October 1949 with the measurement of the velocity of a T59E3 Rocket having a head-end suspended propellant charge.

10. The preliminary planning of rocket facilities for Redstone Arsenal was accomplished by the Office of the Chief of Ordnance. To quote from "Justification of Estimates for Military Establishment, Fiscal Year 1951" dated 3/15/49--

"This project, in the amount of $4,000,000 was included in FY 51 authorizing legislation (HR 7008-S2440) and the first increment of $2,000,000 requested herein is urgently required during FY 51 to keep pace with technical progress and the balanced development of the research program (the bills include $250,000 for the Thiokol Facilities which are to be located at Redstone Arsenal making a total authorization of $4,250,000 for the station."

"This project proposes the modification and new construction required to provide complete laboratory and testing facilities for research and development work on rockets, jatos and related fuels and propellants and facilities for limited preparation of such items."

An itemized list and cost estimate by item is included in this justification separated into first increment in the amount of $2,000,000 and second increment in the amount of $2,000,000. This information was transmitted to Redstone Arsenal by letter dated 23 June 1949, file O.O. 600.1/1127, RSA file 600.1/87 (included in Appendix A, Exhibit I).

11. After preliminary survey of existing buildings, grounds and utilities, the following letter dated 15 November 1949 was received and is quoted in its entirety:

"RECORD
HGJones/lm/6427

15 Nov 1949

SUBJECT: Construction Program for Rocket Facilities

TO: Commanding Officer
Redstone Arsenal
Huntsville, Alabama

1. It was noted in the minutes of the weekly meeting held with the contractors and Redstone Arsenal personnel on 2 November 1949, that the subject of new facilities was mentioned. In order that no confusion shall arise as to responsibilities for the planning of work, certain phases should be assigned to the contractors and to the Arsenal for preparation of drawings and estimates. A breakdown of the facilities proposed for Redstone Arsenal was sent to the Arsenal on 23 June 1949, file 0.0.600.1/1127. A copy of this program is inclosed. It should be noted that the total amount of $4,000,000.00 is the amount estimated to cover the facilities required by the Rohm and Haas Company, and by the Arsenal for the Ordnance facilities. Funds in the amount of $250,000.00 have been budgeted separately for the Thiokol program.

2. The following schedule is suggested:

a. Rohm and Haas - Make layout of new laboratory buildings to be of permanent type construction, brick and concrete; also other buildings that will be required to complete their setup. Plans for facilities should be projected over those believed necessary in the next five years and priorities should be assigned to indicate the relative need for the buildings. These layouts should be in line form, sufficient information included so that they could be furnished to an architect engineer firm for the preparation of final and complete construction drawings. The architect engineer company may be selected by the Corps of Engineers or the Corps of Engineers may do this work with their own facilities. The methods should be complete by March 1950.

b. Thiokol Corporation - Prepare layouts of addition to present office buildings or for new office buildings which ever is

required, and such other additional buildings or major modifications that are required for their research and development work. It should be noted that the total amount available for work in this area will be not more than $250,000.00. This work should also be completed by March 1950.

c. Arsenal - Make all plans and designate location for complete testing facilities, both flight and static. This will include buildings for loading and assembly of rockets, temperature conditions, test stands, control room and locations for instrumentation. These plans should be thoroughly coordinated with both contractors to determine their suitability and convenience for the work to be performed.

3. It is suggested that after preliminary work has been performed to determine tentative size and location of buildings, that a meeting be held to discuss the plans so that unnecessary duplication of work can be avoided.

BY COMMAND OF MAJOR GENERAL FORD:

1 Incl.

H. N. TOFTOY
Colonel, Ord Dept
Assistant

W. J. DURRENBERGER
Lt Col, Ord Dept
Assistant"

12. After discussions between representatives of Redstone and Mr. J. A. Batley of Safety Branch, OCO, Mr Batley and Mr McNamara spent the week of 5 December 1949 at Redstone reviewing the safety considerations of laboratories, of ranges and static stands. On 14 December 1949 a map showing site locations of ORC facilities was forwarded for approval of the Safety Officer. This map located the Computing Laboratory South of Buxton Road and North of Patton Road with the Static Stands located so the exit gases would be directed 30° South of East toward the Tennessee River. The firing area was located to the West of the Computing Laboratory with a safety zone consisting of a 60° segment of a circle. Since this location which provides a maximum length of range would interfere with roads and railroads providing access

from storage and potential manufacturing areas, it was not approved. At a meeting held on 11 January 1950 the site location North of Buxton Road and West of Patton Road where present static testing facilities are located was selected as the location for both static test facilities and the firing area for free flight tests. "There being adequate high ground in the vicinity of Patton and Buxton Roads for the construction of range buildings; while the area to the North and West which will include the impact and danger areas is subject to floods and is generally unsuitable for the construction of permanent buildings."

13. In January of 1950 the Secretary of the Army approved the transfer of guided missile research and development activities from Fort Bliss, Texas to Redstone Arsenal and the establishment of Ordnance Guided Missile Center at this location. This made possible a combined and coordinated research program on missiles and rockets. It was intended that this move would "permit the maximum use of the German scientists skilled in this field, effect further economies of these programs for research and eliminate duplicate and parallel efforts." Plot plans were reviewed to select sites for OGMC and ORC activities which would permit maximum utilization of existing buildings and utilities while providing for economical expansion with the anticipated normal growth of the organization and increase in program activities.

14. On 10 February 1950 preliminary line drawings and specifications for ORC facilities were transmitted to the Mobile District Engineer. On 15 March 1950 complete preliminary line drawings, preliminary specifications, cost estimates and a priority listing were transmitted to the Mobile District Engineer. The "Research & Development Facilities Planning Priority Tabulation" dated 15 March 1950 is included as Appendix A of this report. On 1 July 1950 Contract DA-01-076 ENG-462 was entered between the Mobile District Engineers and the J. E. Sirrine Company of Greenville, South Carolina, Architect Engineer, for preparation of drawings and specifications for these facilities.

15. During the move of the Ordnance Guided Missile Center from Fort Bliss, Texas to Redstone Arsenal, Department of the Army General Order No. 19, 14 June 1950, was issued, which permanently transferred to the jurisdiction of the Chief of Ordnance major portions of lands and facilities formerly a part of Huntsville

Arsenal. Section I, General Order No. 19 is quoted in its entirety:

"I -- Huntsville Arsenal, Alabama -- Effective as of 1 April 1950, Huntsville Arsenal, Alabama, a class II installation under the jurisdiction of the Chief, Chemical Corps, was discontinued and the portions retained by the Department of the Army were consolidated with Redstone Arsenal, Alabama, a class II installation under the jurisdiction of the Chief of Ordnance (AG 680.1 (1 May 50))"

The Chief of Engineers initiated action to dispose of those tracts not transferred to the Chief of Ordnance. Disposition action was suspended by Office, Chief of Engineers on 11 September 1950, but the questionable areas could not be incorporated in permanent plans until May 1951. Thus, in spite of the fact that it enables the development of an integrated test area, the northern portion of the western lands now designated "Range 3" was not available at the time the first plans for permanent test facilities were formulated.

16. Work was accomplished at the arsenal on specific problem assignments under Project TU2-7C "Research on Rocket Motors," "Development Problems," by ORC personnel in addition to the programs being conducted by the resident contractors. Reports were issued by the Research Section and the Engineering Section, of particular note were:

Report No. A2-b dated 28 February 1950 - Final Progress Report "Survey of Propellants for Field Artillery Rockets" and

Report No. A7-a dated 1 July 1950 - Interim Progress Report "15,000 Yard Special Purpose Rocket" by C. J. Koeper, Acting Chief, Engineering Section

The former because it was in large demand and received wide use by contractors. The latter because this and subsequent work by personnel of the present Design Branch, RDD was the basis for a successful rocket weapon development program including launching and handling equipment.

17. During the period that Major Frank J. Austin, Jr. was Chief, ORC, from April 1950 thru July 1950, the major efforts

were directed toward the recruitment and training of personnel. There were no changes in basic organization nor policy during this period. To strengthen the organization, a separate planning office was established under Mr. W. O. Sisco, Jr, who was relieved of his other administrative duties. Lt Col Severin R. Beyma was assigned as Chief of Ordnance Rocket Center in July of 1950 and initiated a review of procedures and a study of assignments and functions within the organization. He was assisted in this task by Mr E. L. Rose who joined the arsenal in August 1950. In September 1950 a Planning Division was established and Mr. W. L. McCulloch was appointed chief of this division.

18. By June 1950 work at Thiokol Corporation on large solid propellant rocket motors advanced to the stage where serious delays would result if a static stand of sufficient thrust capacity were not provided before those included in the MCA budget became available. It was therefore decided to construct a static test stand with instrumentation and auxiliary equipment capable of testing rocket motors developing up to at least 100,000 lbs of thrust. The location of this stand was selected to permit incorporation of this unit in the group of permanent facilities and allow safe operation of the entire group. Design of this stand, including equipment, was accomplished by Thiokol Corporation working in conjunction with ORC and Post Engineer personnel. A design load of 500,000 lb thrust was used as the basis for the design and material specifications. Construction was accomplished by the Post Engineers. This facility was first used in April 1951 with Thiokol Corporation providing test personnel and instrumentation. Operation of this facility has continued by Thiokol Corporation with the cooperation of RDD personnel although the original plans were to incorporate the operation of this unit in the activities of the Test and Evaluation Branch as soon as such action became convenient. Construction of this test stand before final selection of sites for FY 51 items fixed the location of the static test area and imposed limitations on the arrangement of other facilities.

19. In November 1950 preliminary architectural and engineering drawings submitted by J. E. Sirrine Company were reviewed for the purpose of planning acquisition of personnel and equipment and establishing of operating procedures. This review revealed serious deficiencies which limited the usefulness of the facilities as then planned. Changes in location arrangement and orientation including the separation of flight and static facilities in order to comply with requirements for safe

and economical operation were mandatory. An inspection of terrain in order to select more suitable site locations was made and surveys of the apparently suitable locations were started. Then a revised set of criteria were started and a conference was held with representatives of the arsenal, Mobile District Engineers, and J. E. Sirrine Company on 13 December 1950, which was followed by a working session at the offices of the J. E. Sirrine Company at Greenville, South Carolina on 4 January 1951. Preparation of completely new architectural drawings and specifications was initiated at this time although final line drawings and criteria were not supplied to J. E. Sirrine Company until 23 February 1951. This affected all ORC projects, 1 through 14 inclusive; the designs for Computing Laboratory, Instrument Buildings, Static Stands, Flight Stands, Assembly Building, Temperature Conditioning Building, Magazines and Range Layout including utilities were completely changed.

20. It was necessary to formulate proposals for Research and Development facilities to be included in the FY 1952 MCA program during November 1950. It was also requisite to revise the Mobilization Plan of the Arsenal to incorporate ORC and OGMC activities at this same time. The difficulties encounted in arriving at a decision as to which facilities or even which functions are essential to the mission of the arsenal clearly indicated deficiencies in organization and planning. The inadequacy of the AE drawings for FY 1951 facilities to provide the items most urgently required for currently assigned and apparently imminent work emphasized the need for both better organization and better planning; as it was then apparent that essential functions of the organization were being neglected.

21. In order to correct the apparent faults of ORC and arrive at an organizational structure that would assure the performance of all necessary functions including planning for progressive development of the organization, Memorandum from Chief, Ordnance Rocket Center, dated 10 November 1950 was directed to the following: Chief, Research Group; Chief, Project Engineer; Chief, Engineering Design Section; Chief, Test & Instrumentation Group; Chief, Planning Division; Chief, Technical Reports; Librarian; Executive Assistant, ORC; Project Officer, Thiokol Corporation; Project Officer, Rohm and Haas Company. To quote:

"1. Each addressee will prepare by 15 November 1950 a statement of mission, function and duties of his unit supplement by an organization chart. In cases where an individual

represents the entire segment of the organization, only a description of duties need be furnished."

"2. The purpose of this memorandum is to acquire basic information on which to determine an interim Ordnance Rocket Center organization, with prescribed duties and functions for each organizational segment."

It was recognized that organizational structure modifies and determines the character of the function performed as much as function dictates organization. Also it was desired to avoid "over organization" or "too rapid freezing" of structure and duties. Therefore, a flexible interim organization providing maximum training, advancement and recruiting was desired. Reorganization was to be accomplished without disruption of work; therefore, the interim organization was to be accomplished with a minimum change in duties assigned to individuals. The previously neglected functions were to be added to assignments of units doing related work; coordination and supervision of the additional work was to be accomplished by interposing a new organizational level. The organization chart is included in Appendix B, Exhibit I.

22. Assigned research and development projects were seriously delayed due to insufficient personnel competent to conduct or supervise the required work. In December 1950, technically trained enlisted personnel became available, and were assigned to perform work requiring knowledge commensurate with their education and training. By 1 April 1951, 41 enlisted specialists were being utilized by ORC. However, the lack of sufficient experienced personnel to train and supervise the work of the young enlisted men limited the general progress in obtaining maximum benefit from these well educated but inexperienced people. Since these men had an average of eighteen months to serve at the time of their assignment and there was little assurance that they could be retained after separation from the service, a long formal training or standardized apprenticeship was considered impractical. Hence, these men were put to work immediately with the direction and supervision possible from personnel who were already overloaded with tasks approaching their maximum capacity. In most cases, considering conditions, the results were excellent and some of the most promising civilian employees of the RDD at the present time were first assigned as enlisted specialists.

23. The overload of planning, organizing and training made apparent some confusion which was caused by incomplete

understanding and misinterpretation of policy which resulted in lack of uniformity and conflicts in activities at various levels of the organization. Therefore, on 19 January 1951 an Ordnance Rocket Center Research Committee was established. The membership of this committee consisted of Chief, Ordnance Rocket Center, the chiefs of branches, project officers assigned to resident contractors, with the Acting Technical Director serving as chairman. The purpose of the committee included: the examination of research and development projects assigned to determine the best means of accomplishing the specified technical objectives; review of progress of projects to judge effectiveness of attack or need for realignment; review and comment on project proposals prior to submission to higher authority; to define and interpret policies from higher authority so they are adequately explained when transmitted to lower echelons and result in uniform action; to recommend policy changes for ORC. It was the intention that this committee would coordinate activities throughout ORC and define plans and procedures in terms which would be understood by the lower levels of supervision. It was hoped that dissemination and discussion of plans, policies and procedures would result in uniform action from all of the workers.

24. In December 1950 a project for design and development of a close support rocket weapon was assigned to the arsenal with a "crash" schedule for completion of the development. Range firings were required in January 1951 to determine design factors requisite for the rocket to track its trajectory and be stable when launched at both high and low quadrant elevations. This rocket could not be tested at "Range 2" without disrupting essential traffic on Patton and Buxton Roads. "Range 1" was a swamp which would permit neither observation of the complete flight nor recovery of the impacted rounds. Therefore, what had previously been a trench mortar testing site at "Range 3" was repaired, wired, instrumented and put into operation. This range was leased to an agricultural lessee at the time it was needed, and was part of the arsenal property scheduled for disposal. Previous planning had indicated that a suitable firing location in northern portion of this area with impact areas common to Range 1 would be highly desirable if not essential to fulfillment of the arsenal mission. For expediency, due to firing barricades, access roads, etc., the firing point was established at the southern end at the location used for trench mortar projectile tests with the impact area to the north of the present launching site. Since the question of disposal of the property was not settled, this was designated as a temporary range and its utilization could not be considered in planning of permanent facilities until much later. The fact

that maps were issued which could not indicate the complete test area plan continued to cause confusion even after the firing site was relocated and the present range layout became an accomplished fact.

25. The mission of Redstone Arsenal was restated in OCO 10-51 dated 26 February 1951; as it pertains to free rockets, jatos and related items, the changes from the previous statement are:

"To function with Rock Island Arsenal and Picatinny Arsenal as principal research and development agency of the Ordnance Corps for rocket launchers and solid propellants for rockets, respectively."

"To function as the principal research and development, engineering, procurement, and manufacturing or assembly agency for free anti-aircraft rockets."

26. Research and development programs in progress in February 1951 had reached a stage where it became mandatory to operate more than one range or delay and reschedule two important aircraft rocket projects. Therefore, clearing and grading for temporary roads in the "Range 1" area was started, using R&D project funds for this work. The temporary firing site was located on the center line of the planned permanent range sufficient distance from planned construction sites to permit non-interference schedules for flight testing and construction work. Clearing extensive enough to permit observation and instrumentation on a strip 2000 yards long and 1000 yards wide was pushed as rapidly as the flooded condition of the land would permit. An impact area roughly 2000 yards by 2000 yards was cleared to provide for location of impact points and recovery of spent rockets. Temporary barricades and an emplaced launcher were erected. Instrumentation wiring was installed by Test and Evaluation personnel. For expediency range personnel cleared brush while instrumentation men strung wires right behind them. This range was in scheduled operation by 1 May 1951 and has been used continuously since that time.

27. A 2000 foot long completely instrumented range in the "Range 2" area which was started in August 1950 was put into operation on 1 February 1951. This facility was operated until progress on "Range 3" permitted its removal to the safer and more convenient location without appreciable delay of the programs involved.

28. The formulation of a long range overall plan which was started in September 1949 made slow progress due to the urgency of immediate problems which diverted the attention of those individuals responsible for planning. Partial concepts were sketched in writing with tentative organization charts; some functions were listed; apparently necessary items of equipment were added to lists submitted by the operating supervisors as they came to mind; however, no real planning was accomplished. On 9 April 1951 the Chief, Ordnance Rocket Center made the Acting Technical Director together with the Chief of the Planning Group responsible for preparation of a long term plan to provide for accomplishing all of the functions necessary to fulfill the assigned mission. To implement the formulation of an overall plan, the Chief, Test and Evaluation Branch was replaced and assigned to the position of Deputy to the Acting Technical Director to assist in scheduling all programs assigned and to provide for implementation to meet existing and future schedules.

29. By 15 May 1951 a relatively complete set of essential functions, personnel requirements, facility and equipment needs based on requirements anticipated to accomplish the research and development mission of Ordnance Rocket Center had been compiled. Work on methods, procedures and operations planning to determine organizational structure had just started when Chief, Ordnance Rocket Center was directed by the Commanding Officer to submit a firm organization including functional and manning charts for accomplishing the research and development and industrial mission of the arsenal pertaining to free rockets, jatos, launchers and auxiliary equipment by 25 May 1951. The result was the organization of 28 May 1951 which was approved on 20 June 1951 included in "Appendix B" as "Exhibit II". The Industrial Group comprised three people including the stenographer and was to be the nucleus of an organization which would perform functions now assigned to National Procurement Division and Technical and Engineering Division in so far as these pertain to free rockets and jatos. The Planning Group had a functioning Plan Engineering Branch while the rest of that organization existed only on paper.

30. As of 1 July 1951 Ordnance Rocket Center had a total of 164 people including: 83 technical civilians, 33 clerical civilians, 41 enlisted men and 7 officers. In July 1951 plans were made to reorganize the arsenal. These plans included consolidation of research and development activities, including direct supporting functions, pertaining to rockets and guided missiles into one Technical and Engineering Division.

This organization of the arsenal is included as "Exhibit III" of "Appendix B." The Rocket Development Group retained the four operating branches now existing in Rocket Development Division. Organic administrative functions including property and stock control, reports writing, etc. became part of the Office of the Chief. The name of the Research Branch (now Rocket Development Laboratory) was changed to Propulsion Research Branch, though its functions included all those now performed, and exterior ballistics was considered an essential phase of its work. The Engineering Branch became the Design Branch. The Test and Evaluation Branch retained its name and all of its previous functions. The Projects Branch remained unchanged. The Photographic Branch, Technical Library and Planning Group became parts of the new Technical Services Group.

31. The transfer of planning activities to the Technical Services Group of Technical and Engineering Division plus the resignation of the former Chief, Planning Group, ORC at the time of transfer of these activities caused a serious delay in formulating a plan for the new Rocket Development Group. The initial background furnished by the attempt to formulate a plan for ORC was helpful; but no real progress could be expected until the structure of Technical and Engineering Division was reasonably clearly defined and policies were established. At this period day to day work load to meet assignments and commitments in all operating segments was large and the minor aggravations arising from problems caused by a general lack of understanding of the responsibilities and duties assigned to the new organizational segments, together with a natural reluctance in all segments to relinquish the performance of functions previously assigned, created annoyances at all levels of supervision. In brief, "the boss had a rough time" was a statement generally applicable to any individual occupying a position from section chief on up.

32. The formation of the Technical and Engineering Division caused a review of all proposed construction projects for R&D facilities submitted for the FY 1952 and FY 1953 MCA budgets. Since it was mandatory that proposed construction projects for research and development facilities to be included in the FY 53 budget be submitted by 15 August 1951, there was insufficient time to consider major changes in individual items prepared by OGMC and ORC for accomplishing the functions assigned to them in the old organization. Hence, the descriptions and justifications of those items submitted for inclusion in the budget were essentially as originally prepared by OGMC and ORC with minor changes; some items were deleted, additions were made

to the size and scope of some proposed buildings, the size scope and cost estimates of some proposed facilities essential to the work were reduced, priorities were rearranged. However, the short time allotted precluded logical changes of formulation to agree with the new organization before submission. The items submitted did not indicate plans for providing facilities for the new organizational segments.

33. The planning at Redstone prior to August 1951 was based on the concept of a complete set of rocket research and development facilities in the vicinity of Building A-120, except for test areas and ranges, and a complete set of guided missile research and development facilities in Plants Area 1 and contiguous areas. Hazardous static testing of large liquid fuel engines and rocket test areas would have overlapping safety zones. The areas used by resident contractors would be separate and continuous in so far as possible. Arsenal service functions were to be located approximately midway between rocket and guided missile facilities. Facility requirements originated with and initial planning was accomplished by OGMC and ORC personnel independently: coordination at arsenal level was after preparation of initial plans in sufficient detail to justify the facility. Thus, while excellent cooperation between personnel at the working levels of OGMC and ORC existed, the savings in personnel, equipment and effort expected when the Secretary of the Army approved the transfer of guided missile activities from Fort Bliss to Redstone had not been realized prior to the consolidation of all R&D activities in the Technical and Engineering Division. It is not difficult to understand the continued independent action of OGMC and ORC when it is realized that guided missiles activities were originated by a group that had to be semi-autonomous at inception, had developed both working organization and equipment independently and under hardship and was regulated by different controlling groups at higher levels than was the rocket research and development group. Thus, while some functions are identical in rocket and guided missile activities, they are separated by project definitions and controls, and fall under different research and development technical objectives due to the product rather than functional breakdown of activities.

34. The original concept of Redstone Project R-15, Army Project A-373-10, Engineering Building was that this building would house design and engineering activities pertaining to free flight rockets and be located in the immediate vicinity of Building A-120. Similarly, OGMC-8, A-373-16 R&D Design Building was to house design activities pertaining to guided missiles while

CM-3, A-373-9 Research and Development Engineering Building was to house engineering activities reassigned to the Engineering Group. It was decided to relocate these buildings in a single location on the north side of Martin Road east of Dodd Road. This group of buildings was to become the center of Technical and Engineering Division Activities. Redstone Project R-18, Army Project A-373-29, Research Laboratory was originally planned as a facility required to provide for that research in the basic physical sciences necessary to furnish the knowledge required for progress in rocket development activities. Propellants chemistry space was provided by the barricaded wing on A-120 included in the FY 1951 appropriation: the facility requested for the FY 1952 budget would provide space for work in all branches of physics and those branches of chemistry not housed in either laboratory portion of A-120. This was to be a wing appended to the new section of the present building. It was decided to change this concept of Project R-18 and use funds provided by this item to establish a separate research laboratory to conduct research in the basic sciences as a service for the entire arsenal. This laboratory was relocated on the plot plans to a site south of Martin Road and east of Dodd Road in the general area of the buildings mentioned earlier in this paragraph.

35. After informal discussions with Post Engineer personnel, on 8 October 1951 the Post Engineer was notified by memorandum of the change in plans for utilization of the Research Laboratory, R-18. New site locations were submitted for Technical and Engineering Division Facilities at that time. New line drawings, descriptions and preliminary criteria were submitted to the Post Engineer in December 1951. Mr Hannes Luehrsen, Chief, Facilities Planning, Technical Services Group prepared excellent area and building plans which provided for economical expansion of activities; however, these plans were not in complete agreement with existing and planned utilization of areas for rocket activities. For reasons apparent from preceding portions of this report, rocket facilities and area plans were not as complete as those for guided missile facilities. Further records of arsenal planning were incomplete, which, together with uncertainties concerning arsenal boundaries during the 1949-1950 period when areas were designated for rocket activities, added to this confusion. In many cases rocket activities utilized areas on verbal authority of the Commanding Officer with subsequent approval of the planning board inadequately recorded. These conditions resulted in overlapping plans for utilization of some areas for different activities. One of the most questioned areas was that

containing "Range 3". This one was exceptionally difficult as maps issued at the time retention of this area in the arsenal properties were in use long after firm decision and approval of the new arrangement was received. While most questions concerning area utilization are now satisfactorily resolved, the hurt feelings of some of the individuals involved in the competition for space remain, and cooperation between some branch chiefs and the Facilities Planning and Coordination is not yet complete.

36. In the period from August 1951 through January 1952 while reconsideration of items submitted for inclusion in the FY 1952 and FY 1953 MCA budget was progressing, plans were made for incorporating those items previously deleted from FY 52 and FY 53 requests, at arsenal level or higher, in the FY 1954 MCA submission. Rocket Development Group planning had to be accomplished by personnel responsible for mission assignments of the group: those competent to contribute to planning did so in spite of a heavy burden imposed by assigned research and development projects which could not be neglected. Thus, there were delays in the assembling of ideas about new facilities into proposals in sufficient detail to serve as the basis for work by the Planning Group. The Planning Group, in turn, had too few people to work with the operating personnel, so could not determine the adequacy of proposed facilities to meet the requirements imposed by the functions to be accomplished.

37. Two important facilities which were badly neglected because of the inadequacy of personnel available to develop proper criteria were Redstone Project R-16, Army Project No. A-373-11, Enclosed Test Range and Redstone Project R-21, Army Project No. A-373-20, Ballistic Track. Each of these facilities was included in the FY 1952 program before sufficient study to determine exactly the type of facility required, and before the economic aspects of construction and operation were determined. To further complicate procedures, an administrative decision was made to construct the Enclosed Test Range (a facility which should logically be designed as a single unit and which may not be operated with construction work in progress) in two increments. The first increment was to cost $547,000, an amount which would tax the ingenuity of the designer to obtain the minimum of structure and utilities required for successful utilization. In December 1951 a contract was negotiated between the Mobile District Engineer and Parsons-Aerojet Corporation to develop design criteria for these facilities. The results of this contract were unsatisfactory to all parties involved.

38. On 15 February 1952, Redstone Project RH-1, The Gorgas Laboratory, the first major project of the FY 1951 construction program was dedicated. It was a high point in the development of the organization to have the first new permanent facility designed for rocket research and development at Redstone Arsenal in operation.

39. In March 1952, Dr George H. Messerly replaced Col Severin R. Beyma as Chief, Technical and Engineering Division. On 28 April 1952, the Technical and Engineering Division was reorganized. The organization chart for this change is included in Appendix B - Exhibit IV.

40. In June 1951 a program was initiated at Cornell University, administration by Cornell Aeronautical Laboratories and Rochester Ordnance District to study causes of rocket dispersion, and the influence of various factors contributing to dispersion. By January 1952 the survey and evaluation of work accomplished in free rocket ballistics and causes of dispersion indicated that ballistic theory for free flight rockets must be further developed, supplemented by numerical analysis, experimental measurements, and review of basic mechanics of rocket flight before prediction of the effect of design and construction variables on accuracy may be determined without prohibitively costly and extensive range work and statistical analysis. A program for study of the motion of spinning rockets was established at North Carolina State College under the direction of Dr. John W. Cell, and a companion program for the study of the motion of fin stabilized rockets was initiated at the University of Tennessee under the direction of Dr. R. R. Newton. The successful experimental verification of adequacy of theory and determination of empirical parameters for numerical analysis is dependent on the development of adequate facilities and techniques for determination of the motion of the rocket outside of the launcher with sufficient precision to permit significant measurements. This requirement plus the urgent need for a facility to rapidly diagnose design inadequancies and construction failure of rockets under development furnished impetus to defend the construction of an adequate Enclosed Test Range at Redstone Arsenal.

41. Additional justification of facilities for FY 52 and FY 53 were presented before representatives of Office, Chief of Ordnance in January 1952; representatives of Chief of Staff in February 1952; representatives of Office, Chief of Ordnance, Chief of Staff G4 and Bureau of the Budget in March 1952. While

this work on FY 52 and FY 53 was going on, additional justifications and criteria including more complete preliminary drawings for FY 54 were being prepared. In June 1952 a meeting was held between representatives of the arsenal, representatives of Chief of Engineers and the Mobile District Engineer to obtain approval of design changes in FY 52 and 53 items.

42. The "Eighth Joint Army-Navy-Air Force Solid Propellant Group Meeting" was held at Redstone Arsenal during 4, 5, and 6 June 1952. The auditorium of Building A-120 was used for the first time for this meeting. In order to be ready for the meeting, this item of the FY 51 construction program was given priority over all other rocket facilities not to be contractor operated. The first session consisted of invited papers on the relationship between current and future weapons needs and current propellant research and development. Another session consisted of invited papers on selected topics in current propellant research and development. The other sessions included contributed papers on propellant chemistry, interior ballistics, and the ballistic applications of solid propellants. Since there were 45 contributed papers, split sessions were held simultaneously at A-120 and the Gorgas Laboratory. Rohm and Haas Company, Redstone Arsenal Research Division was host for this meeting.

43. In June 1952 a method for experimentally determining the motion of a spinning rocket while in the launching tube was devised and construction of the first segmented rail launcher to use this system was initiated. In August 1952 Dr A. C. Menius, Jr. devised a system for verifying the results of this technique by use of radioisotopes. The radioisotope technique has the advantages of positively distinguishing between front and rear bourrelet contacts with the tube and gives an indication of contact pressure but is expensive and would be prohibitive for gathering the statistics required. Both of these methods have been successfully employed and excellent correlation existed between the electrical contact method and the isotope method. The tests using isotopes were not performed until early 1953: fortunately, the correlation was good and the progress made before verification of results expedited the work by at least six months.

44. In June 1952 work on measurement of shock due to ignition of a large jato was started at Radford Arsenal by Test and Evaluation personnel, while Development Laboratory personnel initiated development of an interim igniter to alleviate difficulties and permit continuation of missile tests. Simultaneously

with testing at Radford, test fixtures were designed to permit this type of work at Redstone. While Allegany Ballistics Laboratory solved the ignition problem in time to avoid use of the interim igniter under development here, the acceleration measurements obtained at Radford proved useful.

45. In June 1952 a purchase order was issued to the Reeves Instrument Company for REAC equipment to be used for ballistic computations. The decision was made to install all computing equipment having wide application in the Computation Laboratory of Guided Missile Development Division so there shall be one computations center on the arsenal. Automatic data reduction equipment, including IBM key punch and sorting machines, will be operated by the Data Reduction Section of Test and Evaluation Branch. Programming will be accomplished by the Computations Laboratory.

46. In August 1952, representatives of both GMDD and RTD attended a facility review meeting by Army Chief of Staff G4 to discuss items submitted for inclusion in the FY 1954 MCA budget. These representatives were not permitted to discuss any of these items, but were informed that no item on the FY 54 construction program would be approved before approval of the official Redstone Arsenal Master Plan, which had not been received by Army Chief of Staff G4 through official channels at that time.

47. Failure of higher authorities to release funds to Mobile District Engineer for use on MCA projects for Redstone Arsenal delayed progress on a large group of MCA facilities, the first increment of FY 1952 released being the only items now under construction. The only MCA budget item now in progress for Rocket Development Division is Range Clearing.

48. Occupancy of Computing Laboratory, Building 855 was started in December 1952. Since then all of the FY 51 rocket facilities have been occupied except item ORC 3 and 6 - Temperature Condition and Cycling Building, where installation of refrigeration equipment by York Corporation is nearing completion. Permanent facilities on "Range 1" are being made ready for their first use in flight testing.

D. Organization

1. The basic organization of the Rocket Development Division provides a logical grouping of activities in which

each organizational unit is performing related or similar functions. The line of command is clearly enough defined that each individual should know to whom he reports and each supervisor should recognize his direct responsibilities and know which subordinates report directly to him. The organization is needlessly weak because the necessary formation of units, sections and branches with direct command responsibilities has resulted in some artificial barriers which prevent the maximum utilization of all of the specific knowledge and information possessed by the individual members of the division. To a lesser extent, functions are partially duplicated in individual branches and sections, i.e. Design Branch performing Project Branch functions, sections of Project Branch doing design work. Some minor changes in the organization and operation of the Office of the Chief, Rocket Development Division can alleviate if not eliminate most of these weaknesses.

2. The Chief, Rocket Development Division now controls activities by review. This is because he does not have the organization required to expedite routine matters and screen from routine actions those decisions which set precedents contrary to existing policy or effect new policy. His present organization also lacks the technical support required to evaluate the work of the division and recommend procedures to expedite progress toward completion of objectives, improve quality of technical work, or initiate those changes which will achieve superior results. The organization recommended is needed at division level close to work performance where immediate action can be initiated and results observed. The change in the organization recommended will free the division chief from those routine duties which keep him in his own office, and will permit him to observe the working of his organization, formulate plans, establish policy and adequately represent his division at meetings and conferences with other organizational segments and with his superiors. Direct contact between the division chief and the working personnel is essential though lines of command must be scrupulously observed and instructions or comments regarding procedure or performance of work should be avoided during these contacts.

3. The organizational structure that will free the chief from details is one that provides deputy chiefs (or advisors to, or technical assistants etc., the name is not important) capable of evaluating technical performance of the division in the scientific or engineering aspects of its work,

and an assistant chief (or deputy chief or executive assistant, or office manager, etc) who expedites day to day routine actions, screens correspondence for compliance with policy and good form, coordinates activities between the organizational segments, and through the branch chiefs insures coordination of actions within the branches. In such a structure the administrative office normally reports to the Assistant Chief.

4. The deputy chiefs, who should be selected for broad knowledge of the technology involved in rocket development, must be thoroughly competent in their specific fields and be completely aware of the latest practices and developments in related fields. At least they must be well informed concerning current projects related to rocket research and development. The deputy chiefs, together with the assistant chief, are the staff essential to the division chief. They render impartial evaluations concerning decisions or requests of branch chiefs, They advise the chief concerning their own field of activity. They recommend formulation of new policy or changes in existing policy within the division and advise the chief concerning the affects of policy originated by higher authority.

5. The assistant chief, according to the definition used herein, is the man who acts as chief in the absence of the chief. In this event, the deputies serve as advisors and carry on their routine work without interuption. Hence, the assistant chief must be far more than a routine paper pusher, he must be meticulously careful of details and completely reliable in conducting business in accordance with the policies of the chief. He is the man who makes the organization run smoothly.

6. The deputy chiefs should be consultants to branch chiefs and to individual workers within the organization; however, it should be recognized that they are advisors and are not in the direct chain of command, except when specifically delegated such authority by the division chief and then only to the extent specified by the division chief.

7. Frequent meetings with the branch chiefs individually and at periodically scheduled conferences with all of the branch chiefs, together with frequent informal tours and personal observations of operations should keep the division chief adequately informed concerning current projects. He should be briefed concerning problem areas by the deputy chiefs. Ability or failure to meet schedules together with funding status should be called

to the attention of the division chief by the assistant chief in sufficient time to avoid problems. The assistance rendered to the chief should not cause him to lose direct contact with his branch chiefs who are his responsible supervisors.

8. Training of employees should be a required function at every level of supervision. The individual supervisors should utilize the abilities of the deputy chiefs to increase the knowledge of their subordinates by requesting help in technical problems and should participate in this type of activity together with their subordinates wherever possible. They should aid their subordinates in planning and organizing their tasks and assist in developing better methods of attack for solution of problems. They should continuously recommend sources for increased knowledge and use every method possible to develop the ability of those under their supervision. They should insure development at all levels of the organization by adding responsibilities at a rate commensurate with the increase in knowledge and capability of the individual to assume responsibility.

9. The Projects Branch being the key to obtaining the maximum benefit from the work of contractors presents a particular challenge. The project engineer is the arsenal's direct contact with the contractor and is the contractor's assistant in making available the knowledge, experience, and assistance of the Ordnance Corps to the contractor. He must be well informed concerning current work in related projects that may be of help in expediting the end objectives of the project or projects assigned to him. The ideal project engineer would be a man who has developed an understanding of the problems of the contractor thru the experience acquired by having himself been directly responsible for the conduct of a similar program which was successfully completed. However, such people are rarely available for assignment as project engineers. Further, men successful in design, research or test activities generally prefer direct performance or direct supervision of work to the vicarious participation essential to the technical supervision of the work of a contractor. The project engineer must also possess a personality which will earn the respect and best efforts of the contractor, attributes which are not essential to a competent individual worker. Thus, while the suggestion that the individuals most competent in other branches be assigned projects in their fields of competence is apparently correct, one usually finds that experience in assisting in a contractor's work as a project engineer is more helpful than specific knowledge. Therefore, the best

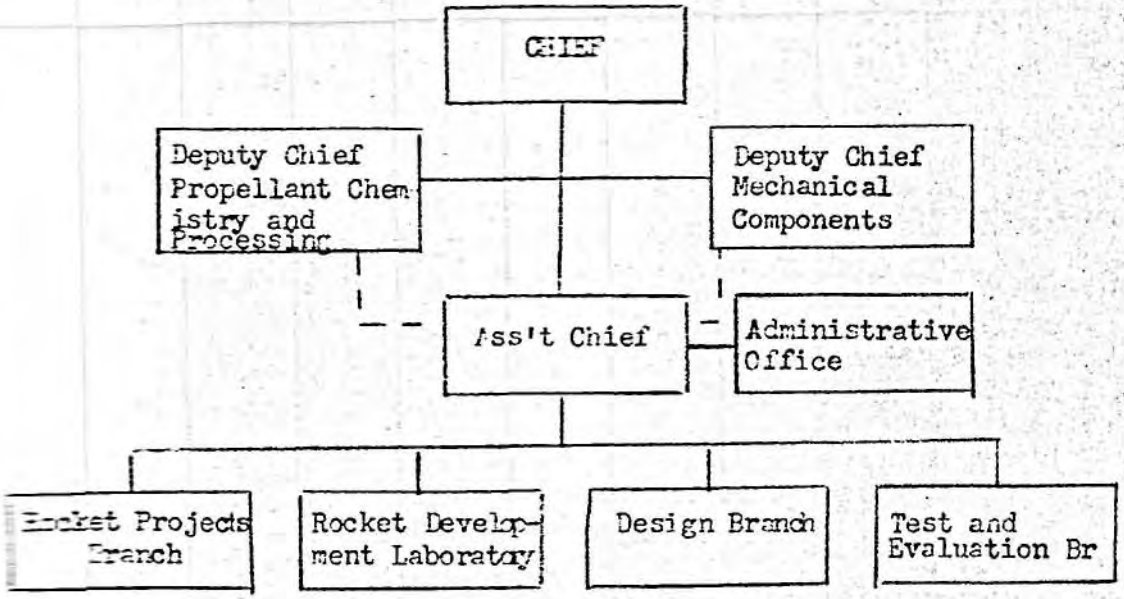
training for a project engineer seems to be apprenticeship to a more experienced successful project engineer. The deterrents to more rapid development of our project engineers seem to be: lack of knowledge of relevant Ordnance Corps policies and procedures, lack of knowledge of the best available sources of information, lack of knowledge of related work in progress at the arsenal or other government establishments, failure to follow reports on related projects, and inability to program, schedule and follow up essential activities. As soon as these difficulties are overcome the ability to anticipate needs and diagnose troubles will develop. It is recommended that on-the-job-training to include review of work in progress at the arsenal and discussion of projects completed and in progress for diagnostic purposes be initiated. It is not recommended that the structure of the Rocket Projects Branch be revised at this time. It is recommended that Chief, Rocket Projects Branch conduct more systematic training of project engineers.

10. The difficulties in the Design Branch and Research Branch are that these segments of the organization are not adequately staffed to perform all necessary functions. Therefore, they are not capable of making a full contribution to the program.

11. The Test and Evaluation Branch should initiate an analysis of operations and procedures. This will result in standardization of many operations, which will lead to simplification of work methods. This study is particularly necessary in range activities and data reduction procedures. A systematic maintenance of equipment program with adequate records of maintenance, unscheduled repairs and alterations of equipment will reduce time and records lost through equipment failures.

12. The proposed organization of the Rocket Development Division, except for the Office of the Chief, is structurally identical to the present organization:

PROPOSED ORGANIZATION OF
ROCKET DEVELOPMENT DIVISION



Since the deputy chiefs review all projects for technical adequacy and suitability of method of attack, they should insure dissemination of pertinent information to the personnel working on projects or problems. It should be their responsibility to prevent performance of an unsuccessful experiment in an identical manner more than once. They should also be well informed of the technical capabilities of all employees of the division to insure that knowledge within the division is utilized before outside help is sought. In this aspect, frequent discussion with and between branch chiefs is helpful and may reveal talents of an employee unknown to his own superior.

E. Facilities

1. Some objective generalities, so fundamental as to be trite, which have been neglected in previous planning have consumed an inordinate amount of time in justification and re-justification, changes and obtaining permission for changes, and selection of site locations and changing of site locations.

First, facilities should be planned to permit completion of functions required by mission assignments. It is senseless to attempt to plan a facility before all of the functions to be accomplished in the facility can be clearly stated. The need for the facility must exist prior to any attempted description. Once having the need, it is simple to list what is expected to be accomplished in or with this particular facility. We are then in a good position to survey existing structures and see if a plan can be formulated which will permit their utilization. Thus, Step 1 of justification is completed.

2. Second, knowing what functions or group of related functions are to be accomplished in this building or with this facility, we can attempt to formulate a plan for accomplishing these functions. This plan will suggest the required equipment and operations. The next step is to sketch a layout of the arrangement of equipment needed and prepare a work flow chart. At this point we have an idea of arrangement with a review to see if all necessary functions have been accomplished to achieve our objective: we are now prepared to study estimated frequency of performing these functions which will indicate need for duplication of equipment or possible provision for expansion at a future date. Third, having a plan for carrying out the functions required and knowing how frequently these functions must be performed in a given unit of time, we can estimate the manpower required. Reviewing the level of skills required for the operations and the background or experience necessary, we can approximate a specification of qualifications for the individuals. Comparing this with our present organization and workload, we can determine what portion of the functions can be achieved with existing manpower, how many additional men may be necessary to conduct the work planned for, what level of qualifications will be required, thus, determining the reasonable expectation of acquiring people to carry out the function.

3. Fourth, a crude line drawing of the facility planned may now be prepared. By considering what utilities are required and what utilities are available, we can prepare ourselves to study possible site locations.

4. The selection of site locations is complicated. First, we must have an area with terrain suitable for constructing our facility. This facility should be conveniently located with respect to other operations required or contributing to its utilization; it should be convenient to those provisions for

necessary services and supporting functions; it should be in a location where exercise of administrative controls are possible; it should not conflict with other activities within the organization or with activities of other organizations; it must be in a location which is assigned to the division or which may be justified for assignment to a division; but above all the location should not interfere with adequate performance of the functions for which the facility is designed.

5. It is relatively obvious that the using organization must feel the need for this facility sufficiently strongly to justify its request. The operating organization should be able to determine exactly what is to be performed in or with the facility and should be able to present a reasonable plan for its utilization. Preliminary arrangement and work flow leading to floor plan should be apparent to the using organization. As soon as this preliminary layout is accomplished and the work plan is known, the Facilities Planning Branch should be contacted and given complete information describing exactly what the user wants and how he expects to accomplish his work with what he is asking for. The other details of the preliminary plan should be worked out cooperatively between the representative of the using organization most completely cognizant of all phases of the operation and the Facilities Planning Branch. Site location should be a joint cooperative venture so the user is able to express his views concerning any factor affecting utility of the proposed construction and while the representative of the planning branch can explain the advantages and disadvantages of desired locations, emphasizing overall plans which may or may not be known to the ultimate user.

6. The first attempt to proceed through all of the logical steps in the design of a rocket facility was before initiation of requests for items to be incorporated in the FY 1954 program. The one exception was the group of facilities, Redstone Project No. R-23, Army Project No. A-373-62 thru A-373-69, inclusive which concerned improvements to certain range areas.

7. It is obvious that the best time to plan for equipping a new facility is when the work plan is formulated. While all details of the equipment cannot be determined at this time, a good enough general idea will evolve to permit more detailed study by those specialists familiar with operation of the particular type of equipment. All installed equipment should be determined as completely as possible before submitting

the facilities request, as installed equipment has a surprisingly large effect on the total cost of the facility and may be difficult to justify unless arrived at by careful study.

8. Following is Ordnance Missile Laboratories Project Priority List dated 22 February 1953 which lists priorities for new construction resulting from a meeting held on 22 February 1953 involving Ordnance Missile Laboratories, Post Engineer, Technical and Engineering Division, Rocket Development Division, Guided Missile Development Division and without concurrence of the resident contractors, Rohm and Haas and Thiokol:

PRIORITY NUMBER	REDSTONE PROJECT NUMBER	ARMY PROJECT NUMBER		TITLE	ESTIMATED COST
1	RH-V	A-373-2	(a)	Crushing & Grinding Facilities	$ 148,291
	RH-VI		(b)	Solventless Extrusion Facilities	461,980
	RH-VII		(c)	Chemical Processing Facil.	167,132
	TH-I		(d)	Laboratory (Thiokol)	206,027
	None		(e)	Security Fencing - All ORC Facilities	36,465
2	TH-7	A-373-24		Addition to Research Lab	314,000
3	None	A-373-3		Modification & Expansion of Facilities	600,000
			(a)	Road Extensions	
			(b)	Pressure Test Building	
			(c)	Combustion Test Stand	
			(d)	Addition to Bldg Nr 412	
			(e)	Connection Between Bldg Nrs 331 & 333	
** 4	OGMC-10	A-373-19		Missile Assembly Shop	1,340,000

PRIORITY NUMBER	REDSTONE PROJECT NUMBER	ARMY PROJECT NUMBER	TITLE	ESTIMATED COST
5	OGMC-1	A-373-5	Guidance Precision Machine Shop	$ 60,000
6	OGMC-13	A-373-26	Guidance & Control Bldg	950,000
7	GM-8	A-373-58	Addition to Guidance & Control Lab	1,137,000
8	GM-9	A-373-59	Addition to Guidance & Control Shop	167,000
9	R-15	A-373-10	Engineering Building	700,000
10	OGMC-3	A-373-7	Measuring Center for Test Area	220,000
11	OGMC-8	A-373-16	R & D Design Bldg	700,000
12	OGMC-14	A-373-28	Addition to Test Area Lab	300,000
13	R-23	A-373-62	Land, Clearing & Grubbing Area	368,000
14	"	A-373-63	Drainage of Area "B"	310,000
15	"	A-373-64	Range Roads, Area "C"	165,000
16	"	A-373-65	Range Storage & Operation Bldg	37,000
17	"	A-373-66	Observation Tower	8,000
18	"	A-373-67	Eight (8) Observation Towers	24,000
19	"	A-373-68	Two (2) Portable Observation Towers	6,000
20	"	A-373-69	Fixed Equip. for Free Flight Range	40,000
21	R-16	A-373-11	Enclosed Test Range	547,000
** 22	OGMC-15	A-373-30	Two (2) Hangars	520,000
23	R-18	A-373-29	Research Laboratory	1,215,000
24	R-21	A-373-20	Ballistic Track	777,000

PRIORITY NUMBER	REDSTONE PROJECT NUMBER	ARMY PROJECT NUMBER	TITLE	ESTIMATED COST
25	OCMC-16	A-373-32	Hangars for Special Vehicles	$ 300,000
26	GM-3	A-373-9	Research & Development Engineering Bldg	1,302,000
27	GM-5	A-373-71	Addition to Propulsion & Fuels Bldg	415,000
28	GM-4	A-373-60	Launching & Handling Bldg	288,000
29	TH-9	A-373-27	Igniter Preparation Bldg	125,000
30	RH-9	A-373-17	Rocket Weapons Develop. Bldg	140,000
31	TH-5	A-373-13	Additional Pilot Facilities	284,000
32	TH-6	A-373-15	Two (2) Static Stands	197,000
33	RH-10	A-373-74	Press Bldg for Solventless Powder Processing Line	60,000
34	"	A-373-73	Control Bldg for Solventless Powder Processing Line	15,000
35	"	A-373-76	Powder Handling Bldg for Solventless Powder Processing Line	39,000
36	"	A-373-75	Oven Bldg for Solventless Powder Processing Line	5,000
37	"	A-373-77	Installed Equipment for Solventless Powder Line	119,000
38	TH-8	A-373-25	Addition to Adm. & Engr Bldg	180,000
39	TH-7	A-373-79	Storage Magazine for Research Lab	3,000
40	R-17	A-373-21	Metal Working Shop	1,150,000

** Equipment has already been procured (cranes)

9. Of the MCA Program FY 52, only OCMC-10, A-373-19 - Missile Assembly Shop and A-373-43 - Barracks are under construction. Changes in criteria, justification of new site location, and changes in preliminary drawings delayed obligating funds on these projects until monies in the program were frozen.

10. Of the list of research and development projects to be included in FY 1955 MCA Program submitted 16 February 1953, Project RA Nr. R-22, Army Nr A-373-105 - Flight Test Stands, $201,000 has been designated Rocket Priority 1; Project RA Nr R-25, Army Nr A-373-101 - Range Instrument Calibration Laboratory, $400,000 has been designated Rocket Priority 2; Project RA Nr R-26, Army Nr A-373-106 - Range Equipment Maintenance Shop - $273,000 has been designated Rocket Priority 3; Project RA Nr R-10, Army Nr A-373-35 - Physical Test Laboratory, $88,000 has been designated Rocket Priority 4. These projects originally presented in the FY 54 submission have been subject of much discussion between Ordnance Missile Laboratories, Post Engineer and Office, Chief of Ordnance.

E. Equipment

1. Equipment should not be ordered until a sufficiently well-known requirement exists to be able to specify precisely what equipment is required. When this type of specification is known, items may be selected from commercial catalogues or Army equipment lists and exact costs determined. Equipment lists should be in continuous preparation and periodically reviewed to discriminate those urgently required, those highly desirable for more economical or more satisfactory performance of functions, and those just desirable to have for occasional use. Continuous preparation of equipment lists will avoid last minute preparation for submission on short notice and will overcome difficulties resulting from justifying desirable items while omitting those actually essential in the rush. Justification of equipment can be on any of the following basis: those essential to perform a specific function required to complete a development; those essential to perform a specific function required to complete a development within a reasonable time; those required to reduce the time and effort consumed in performance of a specific function; and those providing general support resulting in a reduction of overall manpower requirements. Some equipment is required to completely fulfill the function of the Rocket Development Division. Particularly weak is equipment in branches of the sciences of physics. Most essential of this type is equipment for determination of mechanical properties and behavior of materials of construction, including rheology of plastics. It would be ill

advised to include such items on an equipment list before specialists, adequately competent in the fields to plan the necessary operations, are available. It is impossible to order the correct tools without knowing the work to be done and the manner in which this work is to be accomplished. Attempt to list equipment required by the Rocket Development Division will not be made as the only people competent to request equipment are those who must use it.

APPENDIX A - EXHIBIT I

RST 600.1/87
RECORD
HGJones/lm/6427

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ORDNANCE
WASHINGTON, D. C.

CO No. 600.1/1127
ORDTU

23 Jun 1949

SUBJECT: Proposed Construction Program for Rocket Facilities

TO: Commanding Officer
Redstone Arsenal
Huntsville, Alabama

1. An estimate was prepared for inclusion in the ESA budget for the construction of rocket facilities that were considered necessary to determine the rocket research and development work to be carried out at Redstone Arsenal. This program has been included in the 1950 construction budget which is now being considered by Congress. The total estimate is $4,000,000.00, with funds to be supplied as follows:

FY 1950	-	$2,000,000.00
FY 1951	-	1,100,000.00
FY 1952	-	900,000.00

2. To serve as a tentative guide in discussing this program with the Corps of Engineers and in planning the work to be done, the inclosed sheets give the basis on which the estimates were built. Deviations may be allowed as necessary within the limits permitted by funds and legislation.

BY COMMAND OF MAJOR GENERAL HUGHES:

1 Incl. a/n

H. N. TOFTOY
Col, Ord Dept
Assistant

Construction - 1
R & D - 23
Funds - 43

PROPOSED CONSTRUCTION PROGRAM FOR ROCKET FACILITIES AT REDSTONE ARSENAL

FY 1950

Priority	Description	Sq Ft	Est. Cost
1	Modifications to shipping building for conversion to experimental laboratory		$ 50,000.00
2	Modification to (2) buildings for mix room $36,000; roll room $36,000; press room $72,000; inspection room $36,000; and one small test stand $72,000		252,000.00
3	Solid propellant test stands (2) with control building		540,000.00
4	Chemical Laboratory	8,000	320,000.00
5	Temperature conditioning building -80°F to +160°F		450,000.00
6	Flight test range		50,000.00
7	Design and engineering building	8,000	160,000.00
8	Loading and assembly building	1,500	128,000.00
9	Building modification for machine shop area		50,000.00
	Total FY 1950		$2,000,000.00

Incl to Ltr 23 Jun 1949,
RST 600.1/87
00 600.1/1127

APPENDIX A - EXHIBIT I
Page 3

PROPOSED CONSTRUCTION PROGRAM FOR ROCKET FACILITIES AT REDSTONE ARSENAL

FY 1951

Priority	Description	Sq Ft	Est.Cost
1	Building modifications for casting propellant operations (3 buildings w/barricades and sprinkler system) @ $80,000 each		$240,000.00
2	Administration building	8000	160,000.00
3	Liquid propellant test stands w/control building and propellant storage facilities		600,000.00
4	Construction of instrument shop	4000	100,000.00
	Total FY 1951		$1,100,000.00

FY 1952

1	Extension of utilities and service inc. communications and power	200,000.00
2	Process construction of development line and pilot assembly line	450,000.00
3	Construction of batch type N.G. plant	250,000.00
	Total FY 1952	$900,000.00

Incl to Ltr 23 Jun 1949,
RST 600.1/87
OO 600.1/1127

APPENDIX A - EXHIBIT II

Ordnance Department
REDSTONE ARSENAL
Huntsville, Alabama

RESEARCH & DEVELOPMENT FACILITIES PLANNING

PRIORITY TABULATION

Priority No.	Proj or Bldg Identification	Project Description	Preliminary Est Cost
1	RH I	Laboratory, Administration & Engineering Bldg	$ 1,100,000
2	RH II	Solvent Processing Facilities	97,000
3	RH III	Magazines	40,000
4	RH IV	Static Range and Associated Areas	75,000
5	ORC 9	Static Stand A and Instrument Building	245,000
6	ORC 6	Temperature Condition Bldg	206,000
7	ORC 7	Computing Laboratory and Utility Building	309,000
8	ORC 10	Flight Stand	69,000
9	ORC 12	Camera Stand	34,000
10	TH II	Administration & Engineering Building	126,500
11	TH III	Organic Laboratory Relocation	6,000
12	ORC 3	Cycling Building	240,000
13	RH V	Crushing and Grinding Facilities	55,000
14	RH VI	Solventless Extrusion Building	80,000

APPENDIX A - EXHIBIT II
Page 2

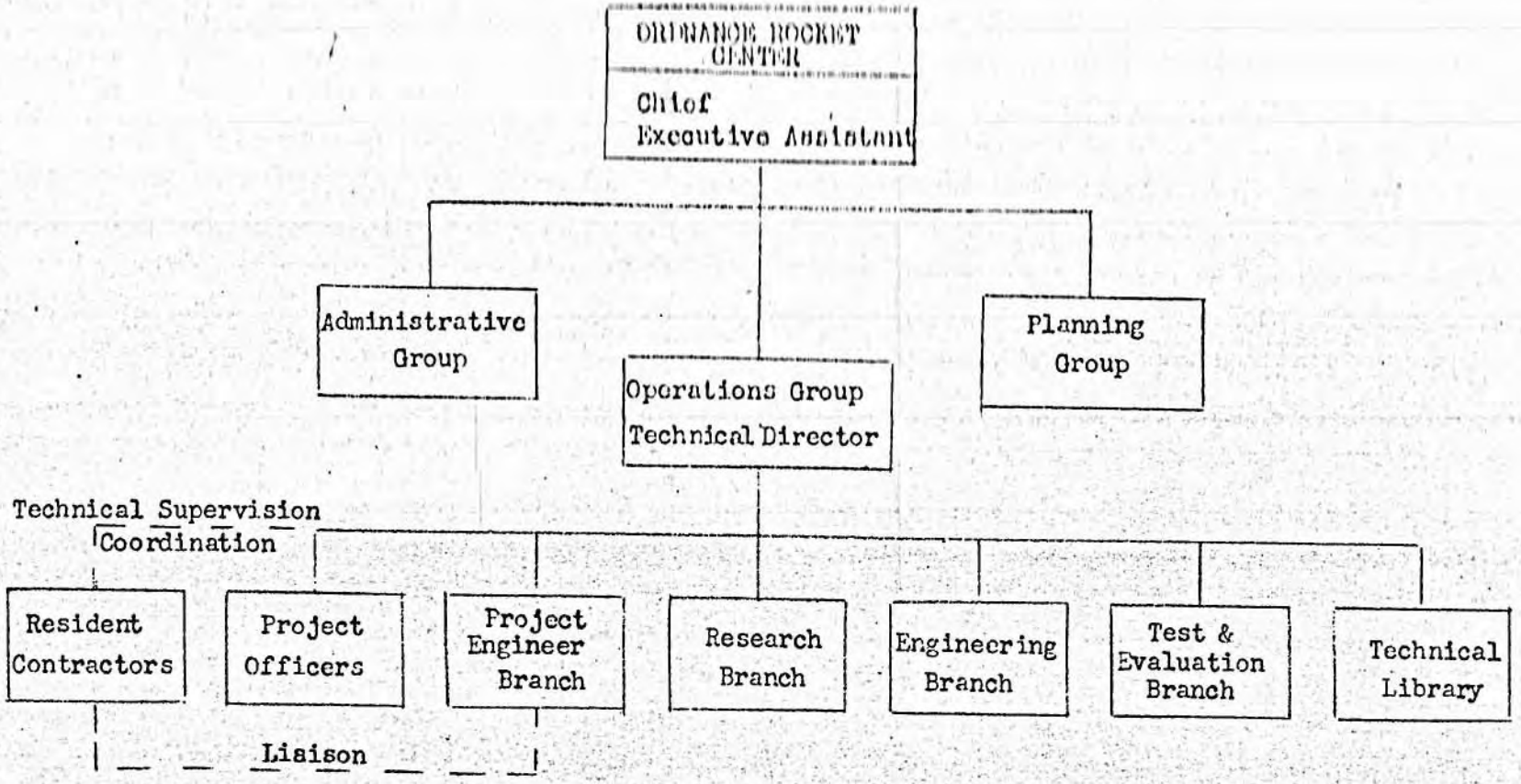
Priority No.	Proj or Bldg Identification	Project Description	Preliminary Est Cost
15	CRC 13	Addition to Laboratory A-120	$ 172,000
16	CRC 14	Propellant Rest House	3,000
17	TH I	Pilot Development Laboratory	112,000
18	EH VII	Chemical Processing Facilities	150,000
19	CRC 1	Solid Propellant Magazine	7,000
20	CRC 2	Igniter Magazine	7,000
21	CRC 4	Assembly Building	206,000
22	CRC 8	Static Stand B	172,000
23	CRC 11	Flight Stand	34,000
24	CRC 5	Liquid Propellant Storage	28,000
25	EH VIII	Development and Pilot Assembly Line	285,000
26	TH IV	Test Stand Facility	5,500
		Sub-total	$ 3,864,000
	CRC 15	*Installed Equipment	186,000
		**Utilities, Roads and Communications	200,000
		Total	$ 4,250,000

*Funds included in Installed Equipment will be expended proportionally with CRC projects.

**Funds included in Utilities, Roads and Communications will be expended proportionally with all projects.

NOTE: Broken line in above list indicates changes in general priority and groups projects that are operationally related.

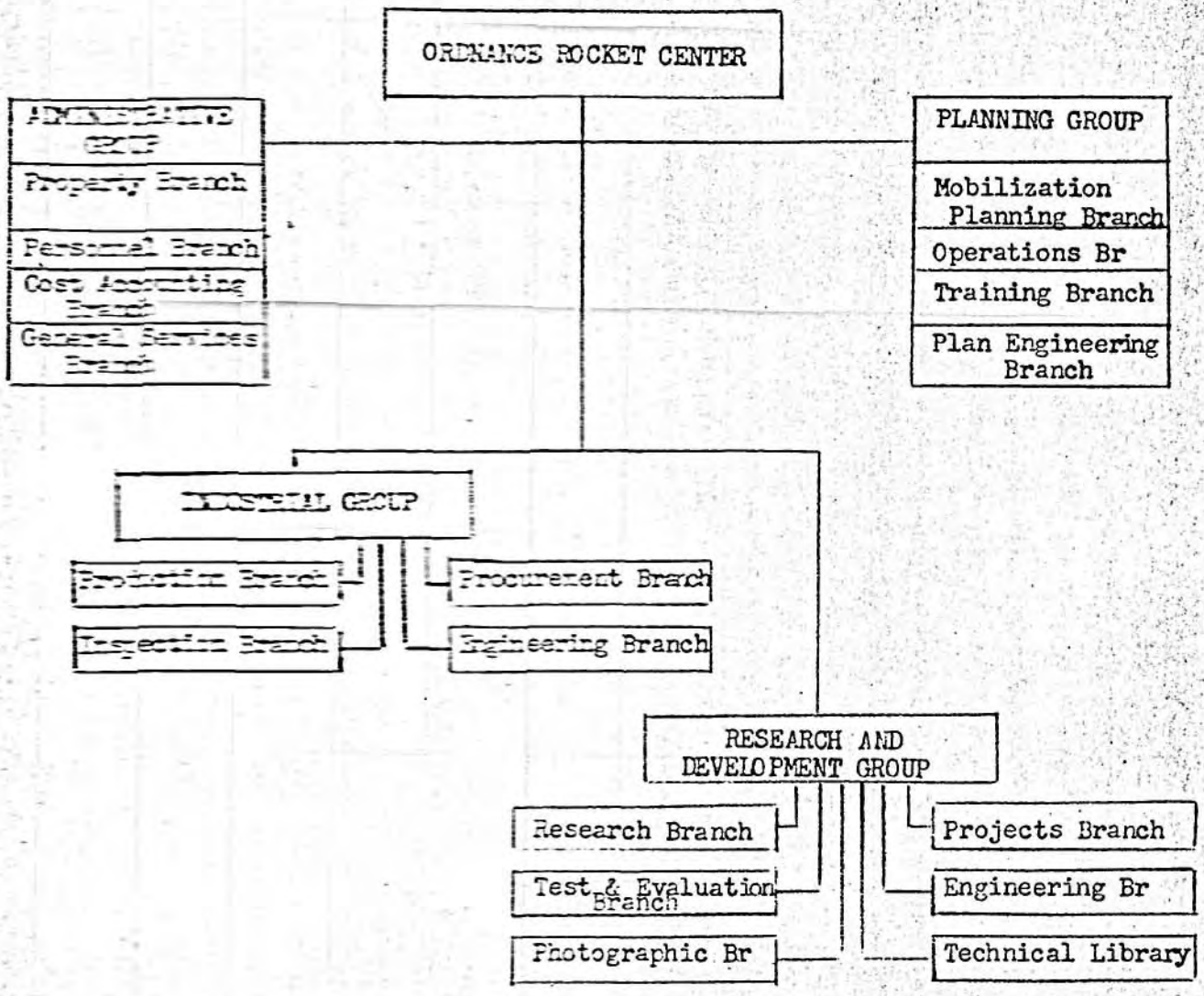
15 March 1950



Organization: 19 January 1951

APPENDIX B
EXHIBIT I

APPENDIX B - EXHIBIT II



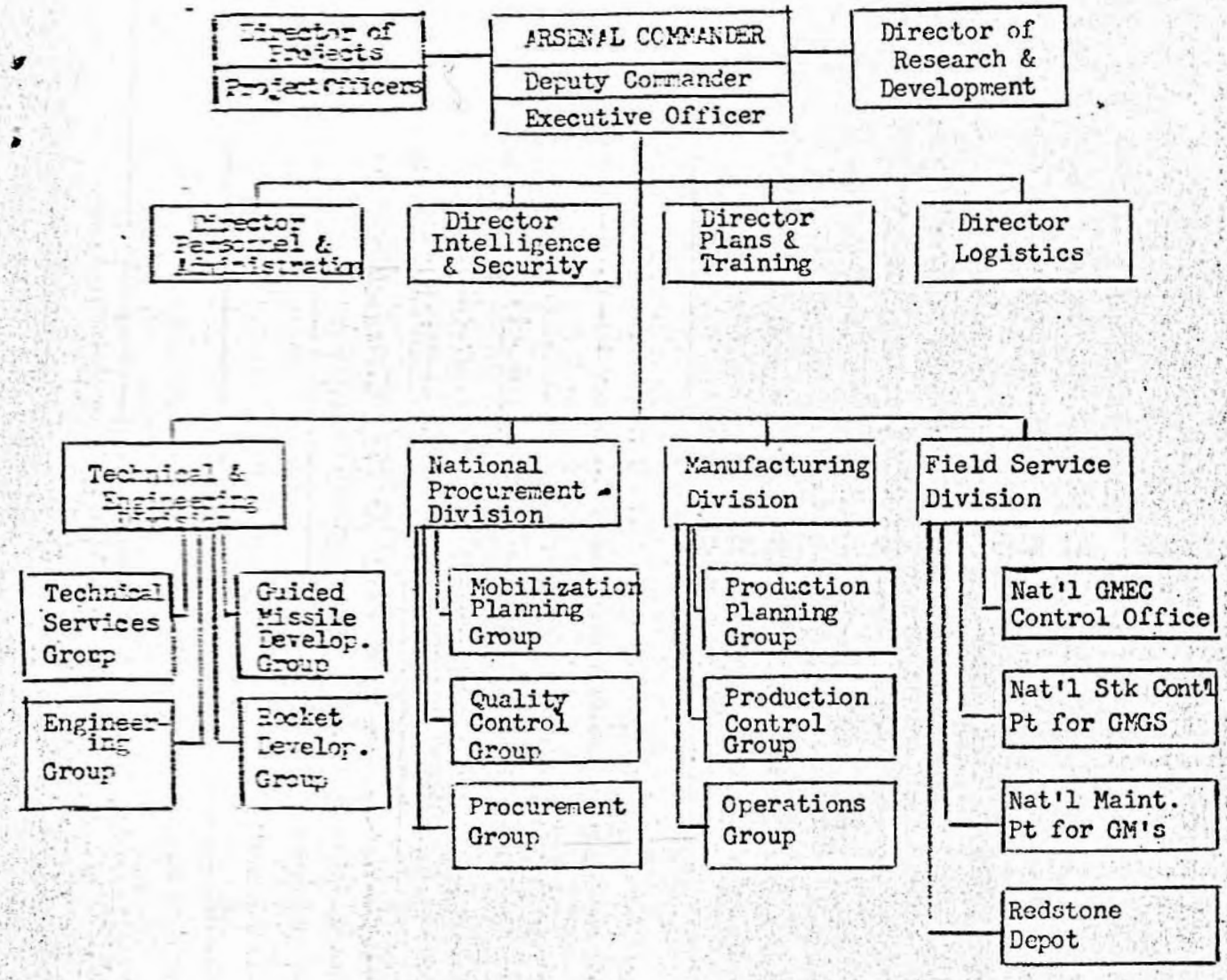
ORGANIZATION OF:

ORDNANCE ROCKET CENTER

20 June 1951

APPENDIX B - EXHIBIT III

REDSTONE ARSENAL



Organization Chart

6 August 1951

APPENDIX B - EXHIBIT IV

[redacted] ORDERS
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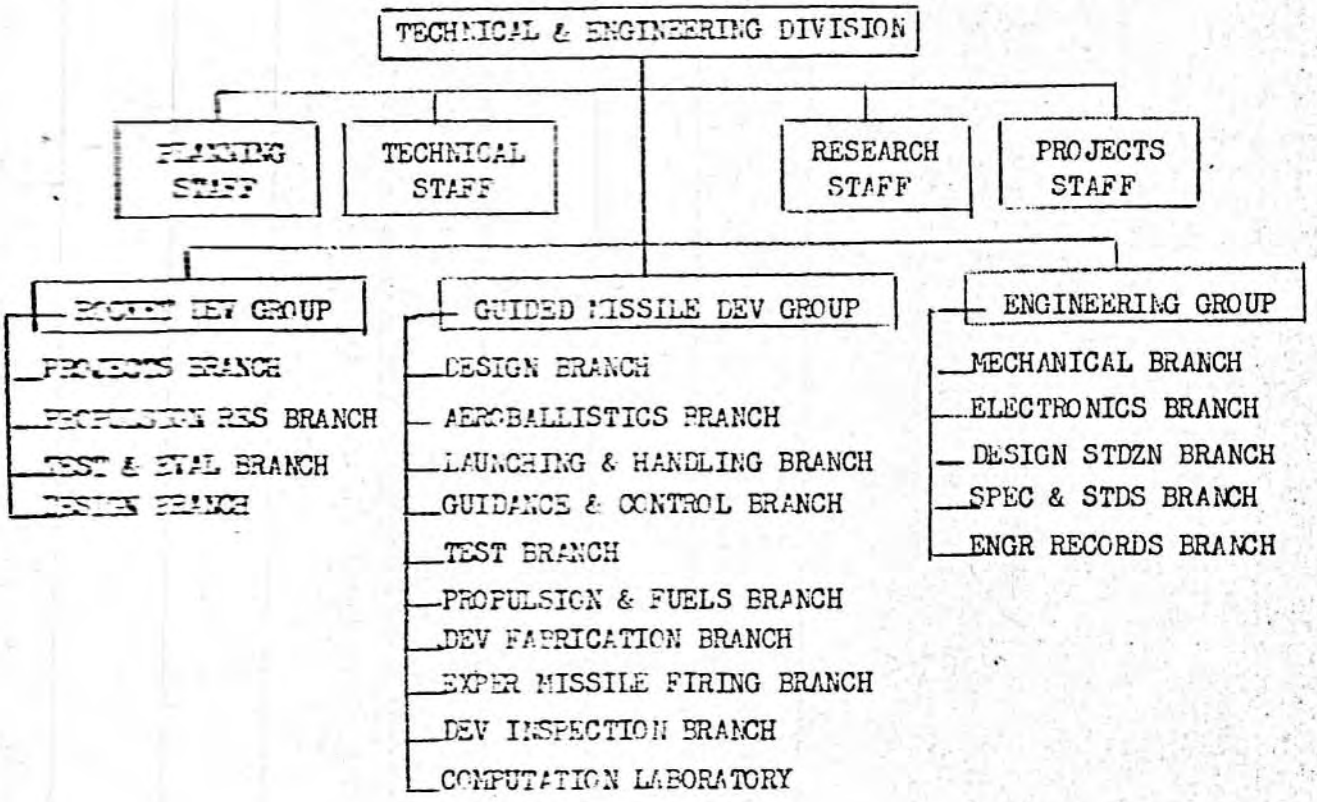
28 April 1952



ORDNANCE CORPS · DEPARTMENT OF THE ARMY

REDSTONE ARSENAL

HUNTSVILLE, ALABAMA

HISTORY

OF

ROCKET DEVELOPMENT DIVISION

by

Fred B. Smith

Prepared Aug 1953

Copy No. 3

HISTORY OF ROCKET DEVELOPMENT DIVISION

by

Fred B. Smith

CONTENTS

II INTRODUCTION

A. General Description and Limitations

1. The plan presented is an overall plan for the organization and utilization of manpower, equipment, and facilities to accomplish that portion of the mission of Redstone Arsenal now assigned to the Rocket Development Division of the Ordnance Missile Laboratories. This plan considers all necessary functions required to fulfill the responsibilities of the division. As presented, it is contingent upon obtaining the help, guidance, services and co-operation of the other units of Ordnance Missile Laboratories and the other agencies of Redstone Arsenal to the maximum extent consistent with assigned responsibilities. Effort has been made to retain maximum flexibility without sacrifice of the supervisory authority necessary to consummate complete responsibility. The result is a general plan based on functional organization: the project or product breakdown is used to insure adequate supervision and continuity of projects and programs within this functional framework.

2. This plan is only as general as the currently assigned mission. It contemplates changes in schedules and workload, the completion of assigned projects, the introduction of new projects, and the shifting of emphasis within the framework of the stated mission. It is not intended to be adaptable to major changes in objective. It is not a mobilization or standby operations plan, but is a day to day work plan.

3. Since the division is in the stages of its first growth, in an activity new to the establishment as well as to most of the personnel, efforts have been made to arrive at schedules and growth rate that should result in balanced acquisition of people, equipment and facilities at a rate commensurate with the acquisition of specialized knowledge and experience. Separation of budgetary controls, time lag between budgetary requests and receipt of funds, uncertainties in the time of availability and amount of funds for a specific purpose, difficulties in recruitment of personnel, and controls on employment all tend to make prediction difficult. These uncertainties emphasize the importance of a long range plan adequate to insure the capability of fulfillment of the entire assigned mission at a reasonably close future date. The plan must be flexible enough to meet contingencies arising from an uncertain and changing program yet be sufficiently detailed to take advantage of any opportunity for strengthening the divisions ability to perform its required functions.

4. Separated portions of the overall plan form various sub-plans such as: a plan for acquisition of facilities from the "MCA" budget; a plan for acquisition of equipment from the "Supply Program" budget; a plan for improving facilities by use of "Repairs and Utilities" funds; a plan for acquisition of personnel; a work program; an on-the-job training program; etc. These sub-plans cannot stand alone: they are contingent on a balanced growth of personnel, equipment, facilities and programs. The separation of budgets and budgetary controls must not obscure the mission and the requirement for attaining the assigned objectives as economically as is possible.

B. Basis for Planning

1. Two related statements of purpose form the basic criteria for determining the effectiveness of the Rocket Development Division. Each of these has been stated in many forms depending on the specific order establishing or reiterating policy. They are restated here to give a convenient check list to be used to determine whether each of these important functions may be most efficiently executed with the implements provided by this plan. These statements of purpose are also a criteria to be used to test the desirability of alternative plans or changes to the plan presented. These statements are first, the important functions of an arsenal (herein limited to those applicable to research and development work) and second, the specific mission of this division.

2. The important research and development functions of an arsenal are:

a. To establish and maintain Ordnance leadership in scientific, engineering, production and management activities so the techniques required for rapid development and increase in production of weapons in time of emergency will be available.

b. To insure the continuous research and development required to put superior weapons in the hands of the troops in time of war.

c. To provide the specialized technical knowledge required to initiate, direct, evaluate and supervise the work of contractors in the fields peculiar to weapons technology.

d. To train a nucleus of civilian and military personnel to be available to expand the arsenal activities, and be available to assist industry in time of mobilization.

e. To investigate development trends in allied fields of civilian endeavor, and initiate that research and development required to exploit advances in technology by application of the increase in knowledge to weapons development or production.

f. To take appropriate action to establish special procedures required in the interest of completion of the development and initial production of urgent and critical items.

g. To keep the technology of weapons design and production alive in time of peace.

3. The mission of the Rocket Development Division is:

a. To function as the principal research and development agency of the Ordnance Corps for free rockets, rocket propellants, and jatos.

b. To design, develop, fabricate, and test rockets, jatos, rocket launchers and/or components therefor, as assigned.

c. To maintain close association with scientific, educational and industrial organizations to insure complete cognizance throughout the field.

d. To exercise technical supervision and coordination over Ordnance Corps Research and Development projects as assigned.

4. The statements of purpose reiterated here are of a most general nature; hence, they are so underdefined that they do not indicate a specific organization or plan. Research and Development projects are funded by Research and Development Orders which specify technical objectives. Utilization of Research and Development funds is further limited by requirements established by Ordnance

Committee Action and specified in Ordnance Committee Minutes. This procedure for initiation of activities tends to obscure the basic purposes of the organization; so there exists grave danger that the management may become so absorbed in the details of specific projects that important functions of the basic program are consequently neglected. The danger of neglecting an important function can be minimized by a sound overall plan supplemented by comprehensive planning and careful programming of specific projects. Project plans must be reviewed for compliance with the assigned mission as well as the specified objectives at the time of initiation, and accomplishments must be checked against the schedule and objectives at specific periods. Careful programming and review of projects will indicate compliance with the stated purposes of the division as well as the effectiveness of the work accomplished. Thus the research and development functions of an arsenal, together with the Mission of the Rocket Development Division, and the specific project objectives become the standards by which achievements may be measured.

5. To provide weapons and equipment having improved performance and increased reliability at reasonable or reduced cost, good design, superior propellants, advanced metallurgical and fabrication practices, sound interior ballistics and rational exterior ballistics must be developed and applied. This statement implies the types and qualifications of required personnel, the general kinds of equipment and facilities necessary, as well as the activities of the division. The geography and existing buildings and utilities of Redstone Arsenal account for most of the other factors determining the plan.

III GENERAL BACKGROUND

A. Definitions

1. To avoid confusion in the interpretation and application of the context, some definitions of common terms are presented. The definitions used in this report are not stated to initiate arguments over rigor, philology or semantics, nor speculations about terminology. Recognition of the scope and limits of the defined terms should free the attention of the reader, thus permitting concentration on the formulation of the plan.

a. Rocket Development Division:
The organization which works as a whole to prosecute the complete functions now stated or implied

in the mission of the Rocket Development Division. The limitation is imposed that functions now assigned to other organizational segments will be conducted in a manner which will make undesirable the duplication of these efforts by the Rocket Development Division. The title used for the organization is not important except in so far as it denotes functions. The present functions and scope of work are not identical to those assigned to its predecessors "The Research and Development Division", "The Ordnance Rocket Center", or "The Rocket Development Group of the Technical and Engineering Division". This is a dynamic organization and the title embraces those changes with time which are consistent with the "Basis for Planning" outlined in the "Introduction" of this report. To reiterate, we are using the functional definition of organization as a whole for a specific mission; which cannot be completely presented on an "Organization Chart" or in an "Organization Manual".

b. Research:
The continuous process of scientific investigation to discover and establish new scientific facts, techniques, and physical relationships. Since all research conducted by this division is directed toward the embodiment of new ideas in weapons or other Ordnance materiel, or in the materials, techniques, methods or processes used in production for the purpose of simplifying logistic or tactical problems, no consideration is given to fundamental or basic research. Supporting and applied research are terms which will be indiscriminately used in this report: there is no convenient method of predicting where or when work that starts as one of these classes will culminate as the other.

c. Development:
The application of known facts to the creation of new or improved materiel or methods.

d. Research and Development:
The functions which extend from the inception of ideas to their final embodiment in all types of materiel, or the techniques, methods, processes and materials used for producing materiel. This includes investigations and exploratory studies necessary to establish scientific and technical data before and during development, and to determine the necessity for and feasibility of further research and/or development. It includes actions related to such modifications of materiel as would affect the technique of its employment: it excludes modifications of developed materiel which are simply for expediting production and do not affect the characteristics of interest to the ultimate user.

B. Fundamental Ideas

1. A precept which has not been questioned to date is that major research and development programs will be accomplished by contractors. The concept of contracting for the maximum amount of research and development work with industrial concerns has been supported by statements of policy at Department of Defense and Department of the Army levels as well as by Ordnance Corps Orders and Memoranda. The responsibility for executing all phases of the stated mission in a manner that will fulfill all research and development functions of the arsenal can be consummated using contractors' services to a maximum, provided continuous programming in accordance with a plan that includes all necessary functions is adhered to, and provided that certain specialized services required to supplement the work of the contractors are adequately developed.

2. The Rocket Development Division must supply adequate technical knowledge and ability to supervise and coordinate the research and development work of contractors on projects assigned. This implies sufficient knowledge to: evaluate the research and development work proposed by contractors or prospective contractors; evaluate work accomplished by contractors; recognize the need for and initiate contracts for new work to exploit results of research and development projects assigned; initiate research and development to exploit advances in allied fields.

3. Recruitment of the best available personnel must be reinforced by continuous on the job training of both formal and informal natures. The informal on the job training must be a continuous daily task of all supervisory personnel. The special technical talents and aptitudes of the better professional and technical people must be transmitted to those working at a lower level by planning and assigning tasks in a way that will insure the working contacts required to broaden the outlook, background and experience at every level of employment. Those having technical training must not be permitted to stagnate and fall behind progress in their field of specialization but must be given assignments that will force acquisition of knowledge that will keep them abreast of new developments and encourage original contributions. Ordnance being specialized must train its personnel and replacements in its peculiar specialties.

4. Personnel in a position to affect the work of contractors by supervision, coordination, advice, direction or evaluation must have adequate information, knowledge, background and good judgment to insure the best efforts and optimum results from the work of the contractors: as a minimum requirement, they should have no adverse affects upon his work. The dangers resulting from misdirection, imposition of unnecessary or meaningless tasks and procedures, the imposition of needless controls or limitations are so grave that only the best qualified personnel available should be utilized as project engineers. Project engineers must be selected for or trained to have a thorough knowledge of their limitations, a maturely cooperative approach to their work with the contractors, a knowledge of the best sources of information and advice, and those qualities of personality which will earn the respect and best efforts of the contractor. The personnel carrying on this function must be well schooled in pertinent policy and must understand and scrupulously observe good ethical practices. Since policy has been and is to accomplish the end item producing portion of the assigned work through contractors, it is essential that contacts and representation of the arsenal with the contractors be the most effective possible. It is essential that, using the proper channels, the project engineer demand and receive the maximum help that the arsenal and the Ordnance Corps as a whole can give him.

5. To establish and maintain Ordnance leadership in scientific, engineering, production and management activities

and to insure continuous research and development required to put superior ordnance in the hands of the troops, it is essential that some research and development be continuously conducted by government employees using government facilities at least to the minimum extent required to train personnel in the specialized knowledge required to initiate, direct, evaluate and supervise the work of contractors. Further, in order to be in a position to economically and rapidly expand the number of contractors engaged in weapons development in time of emergency, it appears advisable to erect certain special facilities to be manned by career federal employees. To take appropriate action to establish special procedures required in the interest of completion of the development and initial production of urgent and critical items, personnel trained in research and development techniques together with the proper tools and facilities are required. In the interest of economy of time and personnel this same organization must be available to aid the project engineer and the contractor when unforeseen difficulties or lack of knowledge arise in the course of a project.

C. Facts Leading to Plan

1. Since this report presents one plan for the accomplishment of the mission of the Rocket Development Division, only that portion of the history of the arsenal which is directly pertinent to the formulation of this plan will be presented in this section. A subsequent section is devoted to a more complete history which indicates how and when there were changes in or deviations from this plan, and why this complete plan was not previously presented.

2. In 1948 the decision was made in the Office of the Chief of Ordnance to assign to an arsenal, as its primary mission, research and development activities in the field of rockets, jatos and rocket launchers. At that time the rocket research and development program necessary to produce the weapons required by the Army and Air Force was suffering from delays caused by insufficient personnel and inadequate facilities. The portion of the required work then being accomplished was in progress at the Office of the Chief of Ordnance, ORDTU, Picatinny Arsenal, Rock Island, and Aberdeen Proving Grounds; however, the magnitude of the work being delayed was too great to warrant its concentration at any of those establishments. Study indicated that there were more suitable facilities that could be adapted to the conduct

of rocket research and development work at Redstone Arsenal than at any other government-owned site. Huntsville Arsenal, a class II installation then under the jurisdiction of the Chief, Chemical Corps, with boundaries common to Redstone Arsenal, was in the process of being liquidated. By consolidation of these properties, adequate land would become available for testing and ranges. The location being strategically well removed from the coast lines and available manpower in the vicinity appearing adequate, the decision was made to assign this mission to Redstone Arsenal.

3. At the time of the decision to locate the center for the Department of the Army for all research and development activities in the field of rockets, jatos and rocket launchers at Redstone Arsenal, this installation had approximately 100 people working on the renovation of ammunition, a small group working on Field Service storage and warehousing activities, housekeeping and supporting activities being conducted by the Post Engineers, and the small headquarters force requisite to the administration of these functions. There were no research and development activities at the arsenal. In December 1948 Lt Col Ernest R. Gillespie was transferred to the arsenal and initiated preparations for the activation of research and development work. In November 1948 Col Carroll D. Hudson was assigned as commanding officer. In January of 1949 recruitment of civilian personnel was initiated and in February 1949, the predecessor of the Rocket Development Division was started with Lt Col Gillespie as its Chief. The major effort at this time was the study of grounds and utilities for the purpose of adapting existing buildings and facilities to the newly assigned functions, and to negotiations for acquisition of certain of the properties of Huntsville Arsenal. Efforts were made to recruit technical specialists to serve as advisors to the Commanding Officer and to assist him in his duties as the Contracting Officer.

4. Negotiations were made between the Ordnance Department and Thiokol Corporation of Trenton, New Jersey (now Thiokol Chemical Corporation) to relocate their operations from Elkton, Maryland to Redstone Arsenal. RAD Order ORDTU 9-10932 dated 4 April 1949 allotted $63,774.00 with instructions, quoted in part, as follows: "The purpose of this RAD Order is to furnish funds to cover the initial cost of relocation of the Thiokol plant, laboratory and equipment therein, from its present

site at Elkton, Maryland to Redstone Arsenal, Huntsville, Alabama. This amount includes approximately $36,774.00 for cost incurred by the contractor in movement, and the remaining $27,000.00 is for the cost of installation of the equipment at Redstone Arsenal. These monies will cover the cost of work incurred through August 1949. Additional funds to complete the installation of the equipment will be supplied when FY 50 funds become available." "Technical Supervision: Redstone Arsenal." This move was accomplished by the end of August 1949.

5. Negotiations were made between the Ordnance Department and Rohm & Haas Company of Philadelphia, Pennsylvania to staff and operate a research and development facility at Redstone. RAD Order ORDTU 9-10960, dated 21 April 1949 allotted $100,000.00 with the following instructions: "This RAD Order is for the purpose of furnishing funds for the cost of a contract with Rohm & Haas for the operation of research and development activities on rocket devices at Redstone Arsenal, Huntsville, Alabama. The work will consist of basic and applied research on propellants, fatos, and rockets including operation of the research laboratory and a pilot line for making propellant samples." "Technical Supervision: Redstone Arsenal."

6. Memorandum from Commanding Officer to Chief, Research and Development Division dated 6 April 1949 is quoted in part:

> "1. The primary responsibility of the Research and Development Division is the technical supervision and coordination of research and development contracts pertaining to rockets administered by the Contracting Officer. To accomplish this primary responsibility a suitable training program will be established and a schedule of lectures pertaining to selected subjects will be published."
>
> "3. To further proper discussion and dissemination of current technical information, an organization to be known as The Redstone Technical Society will be established and shall hold regularly scheduled meetings. It is anticipated that lectures, talks, papers and discussions will be at a level of technical competence that will reflect credit

to this command. The use of films and training aids is to be encouraged and assistance will be provided to aid the speakers in every manner possible."

In May 1949 permission was granted to use Building A-120 for a rocket research laboratory. In June 1949 work was started to adapt an existing barricade 200 feet to the rear of Building A-120 for a static test stand. A 2.36" M7 rocket motor was fired on this static stand on 8 August 1949. As of 1 July 1949 there was a total of 23 persons assigned to research and development activities including both military and civil service personnel. Thiokol Corporation employed 12 people at the arsenal and Rohm & Haas had 4. There were still some questions as to what functions would be required in order to fill the assigned mission, and the interpretation of the mission itself was a subject of much discussion.

7. Ordnance Department Order Number 25-49 dated 18 July 1949, titled "Mission of Redstone Arsenal" is quoted in part:

"2-b. Operate facilities for the research and development of rockets and related items."

"4. Research and Development Functions. For the accomplishment of the research and development mission, the Arsenal will:

a. Conduct basic and applied research, development and testing of free rockets, solid propellants, jatos and related items.

b. Conduct static and range firing in connection with this development.

c. Administer research and development contracts placed within the Arsenal, and exercise technical supervision over such projects.

d. Exercise technical supervision and coordination of all Ordnance Department rocket projects as assigned.

e. Keep abreast of all scientific and technological progress and developments in this field outside of the Ordnance Department. Maintain liaison with educational and scientific institutions, industrial establishments and other government agencies having related interests.

f. Serve as the principal source of technical information within the Ordnance Department on this materiel."

8. In August 1949, a group of people from the Office of the Chief of Ordnance, ORDTU were transferred to Redstone. Certain of the activities formerly conducted by ORDTU were transferred along with the personnel. At this time the first plans for organization of Ordnance Rocket Center to conduct those research and development functions contained in Ordnance Department Order Number 25-49 were formulated keeping the organizational pattern close to that of ORDTU in order to better utilize the particular experiences of the people transferred from ORDTU. The Design Group under Mr. C. J. Koeper (present Chief of Design Branch, RDD) was engaged in making design studies, preliminary feasibility studies, evaluations, drafting and preparation of ideas for new designs for purposes of initiation of contracts, writing and reviewing specifications, etc. The functions assigned to this section of the new organization were identical to its previous assignments in ORDTU. Mr. S. W. Swipp, who was a project engineer in ORDTU previous to his transfer, was assigned the task of organizing a project section to coordinate and exercise technical supervision over the work of contractors. Project Officers were assigned to assist the Contracting Officer in the administration and supervision of the work of the two resident contractors: they were specifically assigned "to serve as representative of the Contracting Officer; to assist the contractor in his preparations to accomplish the work agreed upon; to expedite the accomplishment of the tasks specified in the contract; to serve as liaison between contractor and government agencies." Mr. F. W. James (present Chief of Rocket Development Laboratory) was assigned the task of initiating research and test activities, developing instrumentation and laboratory equipment and supplies, and the training of personnel in test, instrumentation, and research work. The technical library became a part of the Ordnance Rocket Center. Internal administration and planning were retained in the Office of the

Chief, Ordnance Rocket Center. New assignments were to be accomplished by gradual development of additional personnel and facilities. Personnel training was to be expedited by progressively rotating the task assignments of the individuals.

9. The site for a range for shoulder fired and short range free flight testing was selected (present Range #2) and work preparatory to firing was started in August 1949. A wiring system was installed, a launching stand was erected, earth barricades were emplaced, and on 20 September 1949, a 2.36-inch T59 Rocket was launched. On 20 October 1949 the first of a series of demonstrations for visiting officials was conducted: this consisted of firing two 2.36-inch T27E1 Rockets with smoke heads. Acquisition of supplies and equipment, erection of barricades and temporary buildings, wiring and installation of equipment continued; actual project assigned and scheduled testing started on 21 October 1949 with the measurement of the velocity of a T59E3 Rocket having a head-end suspended propellant charge.

10. The preliminary planning of rocket facilities for Redstone Arsenal was accomplished by the Office of the Chief of Ordnance. To quote from "Justification of Estimates for Military Establishment, Fiscal Year 1951" dated 3/15/49--

"This project, in the amount of $4,000,000 was included in FY 51 authorizing legislation (HR 7008-S2440) and the first increment of $2,000,000 requested herein is urgently required during FY 51 to keep pace with technical progress and the balanced development of the research program (the bills include $250,000 for the Thiokol Facilities which are to be located at Redstone Arsenal making a total authorization of $4,250,000 for the station."

"This project proposes the modification and new construction required to provide complete laboratory and testing facilities for research and development work on rockets, jatos and related fuels and propellants and facilities for limited preparation of such items."

An itemized list and cost estimate by item is included in this justification separated into first increment in the amount of $2,000,000 and second increment in the amount of $2,000,000. This information was transmitted to Redstone Arsenal by letter dated 23 June 1949, file O.O. 600.1/1127, RSA file 600.1/87 (included in Appendix A, Exhibit I).

11. After preliminary survey of existing buildings, grounds and utilities, the following letter dated 15 November 1949 was received and is quoted in its entirety:

"RECORD
HGJones/lm/6427

15 Nov 1949

SUBJECT: Construction Program for Rocket Facilities

TO: Commanding Officer
Redstone Arsenal
Huntsville, Alabama

1. It was noted in the minutes of the weekly meeting held with the contractors and Redstone Arsenal personnel on 2 November 1949, that the subject of new facilities was mentioned. In order that no confusion shall arise as to responsibilities for the planning of work, certain phases should be assigned to the contractors and to the Arsenal for preparation of drawings and estimates. A breakdown of the facilities proposed for Redstone Arsenal was sent to the Arsenal on 23 June 1949, file 0.0.600.1/1127. A copy of this program is inclosed. It should be noted that the total amount of $4,000,000.00 is the amount estimated to cover the facilities required by the Rohm and Haas Company, and by the Arsenal for the Ordnance facilities. Funds in the amount of $250,000.00 have been budgeted separately for the Thiokol program.

2. The following schedule is suggested:

a. Rohm and Haas - Make layout of new laboratory buildings to be of permanent type construction, brick and concrete; also other buildings that will be required to complete their setup. Plans for facilities should be projected over those believed necessary in the next five years and priorities should be assigned to indicate the relative need for the buildings. These layouts should be in line form, sufficient information included so that they could be furnished to an architect engineer firm for the preparation of final and complete construction drawings. The architect engineer company may be selected by the Corps of Engineers or the Corps of Engineers may do this work with their own facilities. The methods should be complete by March 1950.

b. Thiokol Corporation - Prepare layouts of addition to present office buildings or for new office buildings which ever is

required, and such other additional buildings or major modifications that are required for their research and development work. It should be noted that the total amount available for work in this area will be not more than $250,000.00. This work should also be completed by March 1950.

c. Arsenal - Make all plans and designate location for complete testing facilities, both flight and static. This will include buildings for loading and assembly of rockets, temperature conditions, test stands, control room and locations for instrumentation. These plans should be thoroughly coordinated with both contractors to determine their suitability and convenience for the work to be performed.

3. It is suggested that after preliminary work has been performed to determine tentative size and location of buildings, that a meeting be held to discuss the plans so that unnecessary duplication of work can be avoided.

BY COMMAND OF MAJOR GENERAL FORD:

1 Incl.

H. N. TOFTOY
Colonel, Ord Dept
Assistant

W. J. DURRENBERGER
Lt Col, Ord Dept
Assistant"

12. After discussions between representatives of Redstone and Mr. J. A. Batley of Safety Branch, OCO, Mr Batley and Mr McNamara spent the week of 5 December 1949 at Redstone reviewing the safety considerations of laboratories, of ranges and static stands. On 14 December 1949 a map showing site locations of ORC facilities was forwarded for approval of the Safety Officer. This map located the Computing Laboratory South of Buxton Road and North of Patton Road with the Static Stands located so the exit gases would be directed 30° South of East toward the Tennessee River. The firing area was located to the West of the Computing Laboratory with a safety zone consisting of a 60° segment of a circle. Since this location which provides a maximum length of range would interfere with roads and railroads providing access

from storage and potential manufacturing areas, it was not approved. At a meeting held on 11 January 1950 the site location North of Buxton Road and West of Patton Road where present static testing facilities are located was selected as the location for both static test facilities and the firing area for free flight tests. "There being adequate high ground in the vicinity of Patton and Buxton Roads for the construction of range buildings; while the area to the North and West which will include the impact and danger areas is subject to floods and is generally unsuitable for the construction of permanent buildings."

13. In January of 1950 the Secretary of the Army approved the transfer of guided missile research and development activities from Fort Bliss, Texas to Redstone Arsenal and the establishment of Ordnance Guided Missile Center at this location. This made possible a combined and coordinated research program on missiles and rockets. It was intended that this move would "permit the maximum use of the German scientists skilled in this field, effect further economies of these programs for research and eliminate duplicate and parallel efforts." Plot plans were reviewed to select sites for OGMC and ORC activities which would permit maximum utilization of existing buildings and utilities while providing for economical expansion with the anticipated normal growth of the organization and increase in program activities.

14. On 10 February 1950 preliminary line drawings and specifications for ORC facilities were transmitted to the Mobile District Engineer. On 15 March 1950 complete preliminary line drawings, preliminary specifications, cost estimates and a priority listing were transmitted to the Mobile District Engineer. The "Research & Development Facilities Planning Priority Tabulation" dated 15 March 1950 is included as Appendix A of this report. On 1 July 1950 Contract DA-01-076 ENG-462 was entered between the Mobile District Engineers and the J. E. Sirrine Company of Greenville, South Carolina, Architect Engineer, for preparation of drawings and specifications for these facilities.

15. During the move of the Ordnance Guided Missile Center from Fort Bliss, Texas to Redstone Arsenal, Department of the Army General Order No. 19, 14 June 1950, was issued, which permanently transferred to the jurisdiction of the Chief of Ordnance major portions of lands and facilities formerly a part of Huntsville

Arsenal. Section I, General Order No. 19 is quoted in its entirety:

"I -- Huntsville Arsenal, Alabama -- Effective as of 1 April 1950, Huntsville Arsenal, Alabama, a class II installation under the jurisdiction of the Chief, Chemical Corps, was discontinued and the portions retained by the Department of the Army were consolidated with Redstone Arsenal, Alabama, a class II installation under the jurisdiction of the Chief of Ordnance (AG 680.1 (1 May 50))"

The Chief of Engineers initiated action to dispose of those tracts not transferred to the Chief of Ordnance. Disposition action was suspended by Office, Chief of Engineers on 11 September 1950, but the questionable areas could not be incorporated in permanent plans until May 1951. Thus, in spite of the fact that it enables the development of an integrated test area, the northern portion of the western lands now designated "Range 3" was not available at the time the first plans for permanent test facilities were formulated.

16. Work was accomplished at the arsenal on specific problem assignments under Project TU2-7C "Research on Rocket Motors," "Development Problems," by ORC personnel in addition to the programs being conducted by the resident contractors. Reports were issued by the Research Section and the Engineering Section, of particular note were:

Report No. A2-b dated 28 February 1950 - Final Progress Report "Survey of Propellants for Field Artillery Rockets" and

Report No. A7-a dated 1 July 1950 - Interim Progress Report "15,000 Yard Special Purpose Rocket" by C. J. Koeper, Acting Chief, Engineering Section

The former because it was in large demand and received wide use by contractors. The latter because this and subsequent work by personnel of the present Design Branch, RDD was the basis for a successful rocket weapon development program including launching and handling equipment.

17. During the period that Major Frank J. Austin, Jr. was Chief, ORC, from April 1950 thru July 1950, the major efforts

were directed toward the recruitment and training of personnel. There were no changes in basic organization nor policy during this period. To strengthen the organization, a separate planning office was established under Mr. W. O. Sisco, Jr, who was relieved of his other administrative duties. Lt Col Severin R. Beyma was assigned as Chief of Ordnance Rocket Center in July of 1950 and initiated a review of procedures and a study of assignments and functions within the organization. He was assisted in this task by Mr E. L. Rose who joined the arsenal in August 1950. In September 1950 a Planning Division was established and Mr. W. L. McCulloch was appointed chief of this division.

18. By June 1950 work at Thiokol Corporation on large solid propellant rocket motors advanced to the stage where serious delays would result if a static stand of sufficient thrust capacity were not provided before those included in the MCA budget became available. It was therefore decided to construct a static test stand with instrumentation and auxiliary equipment capable of testing rocket motors developing up to at least 100,000 lbs of thrust. The location of this stand was selected to permit incorporation of this unit in the group of permanent facilities and allow safe operation of the entire group. Design of this stand, including equipment, was accomplished by Thiokol Corporation working in conjunction with ORC and Post Engineer personnel. A design load of 500,000 lb thrust was used as the basis for the design and material specifications. Construction was accomplished by the Post Engineers. This facility was first used in April 1951 with Thiokol Corporation providing test personnel and instrumentation. Operation of this facility has continued by Thiokol Corporation with the cooperation of RDD personnel although the original plans were to incorporate the operation of this unit in the activities of the Test and Evaluation Branch as soon as such action became convenient. Construction of this test stand before final selection of sites for FY 51 items fixed the location of the static test area and imposed limitations on the arrangement of other facilities.

19. In November 1950 preliminary architectural and engineering drawings submitted by J. E. Sirrine Company were reviewed for the purpose of planning acquisition of personnel and equipment and establishing of operating procedures. This review revealed serious deficiencies which limited the usefulness of the facilities as then planned. Changes in location arrangement and orientation including the separation of flight and static facilities in order to comply with requirements for safe

and economical operation were mandatory. An inspection of terrain in order to select more suitable site locations was made and surveys of the apparently suitable locations were started. Then a revised set of criteria were started and a conference was held with representatives of the arsenal, Mobile District Engineers, and J. E. Sirrine Company on 13 December 1950, which was followed by a working session at the offices of the J. E. Sirrine Company at Greenville, South Carolina on 4 January 1951. Preparation of completely new architectural drawings and specifications was initiated at this time although final line drawings and criteria were not supplied to J. E. Sirrine Company until 23 February 1951. This affected all ORC projects, 1 through 14 inclusive; the designs for Computing Laboratory, Instrument Buildings, Static Stands, Flight Stands, Assembly Building, Temperature Conditioning Building, Magazines and Range Layout including utilities were completely changed.

20. It was necessary to formulate proposals for Research and Development facilities to be included in the FY 1952 MCA program during November 1950. It was also requisite to revise the Mobilization Plan of the Arsenal to incorporate ORC and OGMC activities at this same time. The difficulties encounted in arriving at a decision as to which facilities or even which functions are essential to the mission of the arsenal clearly indicated deficiencies in organization and planning. The inadequacy of the AE drawings for FY 1951 facilities to provide the items most urgently required for currently assigned and apparently imminent work emphasized the need for both better organization and better planning; as it was then apparent that essential functions of the organization were being neglected.

21. In order to correct the apparent faults of ORC and arrive at an organizational structure that would assure the performance of all necessary functions including planning for progressive development of the organization, Memorandum from Chief, Ordnance Rocket Center, dated 10 November 1950 was directed to the following: Chief, Research Group; Chief, Project Engineer; Chief, Engineering Design Section; Chief, Test & Instrumentation Group; Chief, Planning Division; Chief, Technical Reports; Librarian; Executive Assistant, ORC; Project Officer, Thiokol Corporation; Project Officer, Rohm and Haas Company. To quote:

"1. Each addressee will prepare by 15 November 1950 a statement of mission, function and duties of his unit supplement by an organization chart. In cases where an individual

represents the entire segment of the organization, only a description of duties need be furnished."

"2. The purpose of this memorandum is to acquire basic information on which to determine an interim Ordnance Rocket Center organization, with prescribed duties and functions for each organizational segment."

It was recognized that organizational structure modifies and determines the character of the function performed as much as function dictates organization. Also it was desired to avoid "over organization" or "too rapid freezing" of structure and duties. Therefore, a flexible interim organization providing maximum training, advancement and recruiting was desired. Reorganization was to be accomplished without disruption of work; therefore, the interim organization was to be accomplished with a minimum change in duties assigned to individuals. The previously neglected functions were to be added to assignments of units doing related work; coordination and supervision of the additional work was to be accomplished by interposing a new organizational level. The organization chart is included in Appendix B, Exhibit I.

22. Assigned research and development projects were seriously delayed due to insufficient personnel competent to conduct or supervise the required work. In December 1950, technically trained enlisted personnel became available, and were assigned to perform work requiring knowledge commensurate with their education and training. By 1 April 1951, 41 enlisted specialists were being utilized by ORC. However, the lack of sufficient experienced personnel to train and supervise the work of the young enlisted men limited the general progress in obtaining maximum benefit from these well educated but inexperienced people. Since these men had an average of eighteen months to serve at the time of their assignment and there was little assurance that they could be retained after separation from the service, a long formal training or standardized apprenticeship was considered impractical. Hence, these men were put to work immediately with the direction and supervision possible from personnel who were already overloaded with tasks approaching their maximum capacity. In most cases, considering conditions, the results were excellent and some of the most promising civilian employees of the RDD at the present time were first assigned as enlisted specialists.

23. The overload of planning, organizing and training made apparent some confusion which was caused by incomplete

understanding and misinterpretation of policy which resulted in lack of uniformity and conflicts in activities at various levels of the organization. Therefore, on 19 January 1951 an Ordnance Rocket Center Research Committee was established. The membership of this committee consisted of Chief, Ordnance Rocket Center, the chiefs of branches, project officers assigned to resident contractors, with the Acting Technical Director serving as chairman. The purpose of the committee included: the examination of research and development projects assigned to determine the best means of accomplishing the specified technical objectives; review of progress of projects to judge effectiveness of attack or need for realignment; review and comment on project proposals prior to submission to higher authority; to define and interpret policies from higher authority so they are adequately explained when transmitted to lower echelons and result in uniform action; to recommend policy changes for ORC. It was the intention that this committee would coordinate activities throughout ORC and define plans and procedures in terms which would be understood by the lower levels of supervision. It was hoped that dissemination and discussion of plans, policies and procedures would result in uniform action from all of the workers.

24. In December 1950 a project for design and development of a close support rocket weapon was assigned to the arsenal with a "crash" schedule for completion of the development. Range firings were required in January 1951 to determine design factors requisite for the rocket to track its trajectory and be stable when launched at both high and low quadrant elevations. This rocket could not be tested at "Range 2" without disrupting essential traffic on Patton and Buxton Roads. "Range 1" was a swamp which would permit neither observation of the complete flight nor recovery of the impacted rounds. Therefore, what had previously been a trench mortar testing site at "Range 3" was repaired, wired, instrumented and put into operation. This range was leased to an agricultural lessee at the time it was needed, and was part of the arsenal property scheduled for disposal. Previous planning had indicated that a suitable firing location in northern portion of this area with impact areas common to Range 1 would be highly desirable if not essential to fulfillment of the arsenal mission. For expediency, due to firing barricades, access roads, etc., the firing point was established at the southern end at the location used for trench mortar projectile tests with the impact area to the north of the present launching site. Since the question of disposal of the property was not settled, this was designated as a temporary range and its utilization could not be considered in planning of permanent facilities until much later. The fact

that maps were issued which could not indicate the complete test area plan continued to cause confusion even after the firing site was relocated and the present range layout became an accomplished fact.

25. The mission of Redstone Arsenal was restated in OCO 10-51 dated 26 February 1951; as it pertains to free rockets, jatos and related items, the changes from the previous statement are:

"To function with Rock Island Arsenal and Picatinny Arsenal as principal research and development agency of the Ordnance Corps for rocket launchers and solid propellants for rockets, respectively."

"To function as the principal research and development, engineering, procurement, and manufacturing or assembly agency for free anti-aircraft rockets."

26. Research and development programs in progress in February 1951 had reached a stage where it became mandatory to operate more than one range or delay and reschedule two important aircraft rocket projects. Therefore, clearing and grading for temporary roads in the "Range 1" area was started, using R&D project funds for this work. The temporary firing site was located on the center line of the planned permanent range sufficient distance from planned construction sites to permit non-interference schedules for flight testing and construction work. Clearing extensive enough to permit observation and instrumentation on a strip 2000 yards long and 1000 yards wide was pushed as rapidly as the flooded condition of the land would permit. An impact area roughly 2000 yards by 2000 yards was cleared to provide for location of impact points and recovery of spent rockets. Temporary barricades and an emplaced launcher were erected. Instrumentation wiring was installed by Test and Evaluation personnel. For expediency range personnel cleared brush while instrumentation men strung wires right behind them. This range was in scheduled operation by 1 May 1951 and has been used continuously since that time.

27. A 2000 foot long completely instrumented range in the "Range 2" area which was started in August 1950 was put into operation on 1 February 1951. This facility was operated until progress on "Range 3" permitted its removal to the safer and more convenient location without appreciable delay of the programs involved.

28. The formulation of a long range overall plan which was started in September 1949 made slow progress due to the urgency of immediate problems which diverted the attention of those individuals responsible for planning. Partial concepts were sketched in writing with tentative organization charts; some functions were listed; apparently necessary items of equipment were added to lists submitted by the operating supervisors as they came to mind; however, no real planning was accomplished. On 9 April 1951 the Chief, Ordnance Rocket Center made the Acting Technical Director together with the Chief of the Planning Group responsible for preparation of a long term plan to provide for accomplishing all of the functions necessary to fulfill the assigned mission. To implement the formulation of an overall plan, the Chief, Test and Evaluation Branch was replaced and assigned to the position of Deputy to the Acting Technical Director to assist in scheduling all programs assigned and to provide for implementation to meet existing and future schedules.

29. By 15 May 1951 a relatively complete set of essential functions, personnel requirements, facility and equipment needs based on requirements anticipated to accomplish the research and development mission of Ordnance Rocket Center had been compiled. Work on methods, procedures and operations planning to determine organizational structure had just started when Chief, Ordnance Rocket Center was directed by the Commanding Officer to submit a firm organization including functional and manning charts for accomplishing the research and development and industrial mission of the arsenal pertaining to free rockets, jatos, launchers and auxiliary equipment by 25 May 1951. The result was the organization of 28 May 1951 which was approved on 20 June 1951 included in "Appendix B" as "Exhibit II". The Industrial Group comprised three people including the stenographer and was to be the nucleus of an organization which would perform functions now assigned to National Procurement Division and Technical and Engineering Division in so far as these pertain to free rockets and jatos. The Planning Group had a functioning Plan Engineering Branch while the rest of that organization existed only on paper.

30. As of 1 July 1951 Ordnance Rocket Center had a total of 164 people including: 83 technical civilians, 33 clerical civilians, 41 enlisted men and 7 officers. In July 1951 plans were made to reorganize the arsenal. These plans included consolidation of research and development activities, including direct supporting functions, pertaining to rockets and guided missiles into one Technical and Engineering Division.

This organization of the arsenal is included as "Exhibit III" of "Appendix B." The Rocket Development Group retained the four operating branches now existing in Rocket Development Division. Organic administrative functions including property and stock control, reports writing, etc. became part of the Office of the Chief. The name of the Research Branch (now Rocket Development Laboratory) was changed to Propulsion Research Branch, though its functions included all those now performed, and exterior ballistics was considered an essential phase of its work. The Engineering Branch became the Design Branch. The Test and Evaluation Branch retained its name and all of its previous functions. The Projects Branch remained unchanged. The Photographic Branch, Technical Library and Planning Group became parts of the new Technical Services Group.

31. The transfer of planning activities to the Technical Services Group of Technical and Engineering Division plus the resignation of the former Chief, Planning Group, ORC at the time of transfer of these activities caused a serious delay in formulating a plan for the new Rocket Development Group. The initial background furnished by the attempt to formulate a plan for ORC was helpful; but no real progress could be expected until the structure of Technical and Engineering Division was reasonably clearly defined and policies were established. At this period day to day work load to meet assignments and commitments in all operating segments was large and the minor aggravations arising from problems caused by a general lack of understanding of the responsibilities and duties assigned to the new organizational segments, together with a natural reluctance in all segments to relinquish the performance of functions previously assigned, created annoyances at all levels of supervision. In brief, "the boss had a rough time" was a statement generally applicable to any individual occupying a position from section chief on up.

32. The formation of the Technical and Engineering Division caused a review of all proposed construction projects for R&D facilities submitted for the FY 1952 and FY 1953 MCA budgets. Since it was mandatory that proposed construction projects for research and development facilities to be included in the FY 53 budget be submitted by 15 August 1951, there was insufficient time to consider major changes in individual items prepared by OGMC and ORC for accomplishing the functions assigned to them in the old organization. Hence, the descriptions and justifications of those items submitted for inclusion in the budget were essentially as originally prepared by OGMC and ORC with minor changes; some items were deleted, additions were made

to the size and scope of some proposed buildings, the size scope and cost estimates of some proposed facilities essential to the work were reduced, priorities were rearranged. However, the short time allotted precluded logical changes of formulation to agree with the new organization before submission. The items submitted did not indicate plans for providing facilities for the new organizational segments.

33. The planning at Redstone prior to August 1951 was based on the concept of a complete set of rocket research and development facilities in the vicinity of Building A-120, except for test areas and ranges, and a complete set of guided missile research and development facilities in Plants Area 1 and contiguous areas. Hazardous static testing of large liquid fuel engines and rocket test areas would have overlapping safety zones. The areas used by resident contractors would be separate and continuous in so far as possible. Arsenal service functions were to be located approximately midway between rocket and guided missile facilities. Facility requirements originated with and initial planning was accomplished by OGMC and ORC personnel independently: coordination at arsenal level was after preparation of initial plans in sufficient detail to justify the facility. Thus, while excellent cooperation between personnel at the working levels of OGMC and ORC existed, the savings in personnel, equipment and effort expected when the Secretary of the Army approved the transfer of guided missile activities from Fort Bliss to Redstone had not been realized prior to the consolidation of all R&D activities in the Technical and Engineering Division. It is not difficult to understand the continued independent action of OGMC and ORC when it is realized that guided missiles activities were originated by a group that had to be semi-autonomous at inception, had developed both working organization and equipment independently and under hardship and was regulated by different controlling groups at higher levels than was the rocket research and development group. Thus, while some functions are identical in rocket and guided missile activities, they are separated by project definitions and controls, and fall under different research and development technical objectives due to the product rather than functional breakdown of activities.

34. The original concept of Redstone Project R-15, Army Project A-373-10, Engineering Building was that this building would house design and engineering activities pertaining to free flight rockets and be located in the immediate vicinity of Building A-120. Similarly, OGMC-8, A-373-16 R&D Design Building was to house design activities pertaining to guided missiles while

CM-3, A-373-9 Research and Development Engineering Building was to house engineering activities reassigned to the Engineering Group. It was decided to relocate these buildings in a single location on the north side of Martin Road east of Dodd Road. This group of buildings was to become the center of Technical and Engineering Division Activities. Redstone Project R-18, Army Project A-373-29, Research Laboratory was originally planned as a facility required to provide for that research in the basic physical sciences necessary to furnish the knowledge required for progress in rocket development activities. Propellants chemistry space was provided by the barricaded wing on A-120 included in the FY 1951 appropriation: the facility requested for the FY 1952 budget would provide space for work in all branches of physics and those branches of chemistry not housed in either laboratory portion of A-120. This was to be a wing appended to the new section of the present building. It was decided to change this concept of Project R-18 and use funds provided by this item to establish a separate research laboratory to conduct research in the basic sciences as a service for the entire arsenal. This laboratory was relocated on the plot plans to a site south of Martin Road and east of Dodd Road in the general area of the buildings mentioned earlier in this paragraph.

35. After informal discussions with Post Engineer personnel, on 8 October 1951 the Post Engineer was notified by memorandum of the change in plans for utilization of the Research Laboratory, R-18. New site locations were submitted for Technical and Engineering Division Facilities at that time. New line drawings, descriptions and preliminary criteria were submitted to the Post Engineer in December 1951. Mr Hannes Luehrsen, Chief, Facilities Planning, Technical Services Group prepared excellent area and building plans which provided for economical expansion of activities; however, these plans were not in complete agreement with existing and planned utilization of areas for rocket activities. For reasons apparent from preceding portions of this report, rocket facilities and area plans were not as complete as those for guided missile facilities. Further records of arsenal planning were incomplete, which, together with uncertainties concerning arsenal boundaries during the 1949-1950 period when areas were designated for rocket activities, added to this confusion. In many cases rocket activities utilized areas on verbal authority of the Commanding Officer with subsequent approval of the planning board inadequately recorded. These conditions resulted in overlapping plans for utilization of some areas for different activities. One of the most questioned areas was that

containing "Range 3". This one was exceptionally difficult as maps issued at the time retention of this area in the arsenal properties were in use long after firm decision and approval of the new arrangement was received. While most questions concerning area utilization are now satisfactorily resolved, the hurt feelings of some of the individuals involved in the competition for space remain, and cooperation between some branch chiefs and the Facilities Planning and Coordination is not yet complete.

36. In the period from August 1951 through January 1952 while reconsideration of items submitted for inclusion in the FY 1952 and FY 1953 MCA budget was progressing, plans were made for incorporating those items previously deleted from FY 52 and FY 53 requests, at arsenal level or higher, in the FY 1954 MCA submission. Rocket Development Group planning had to be accomplished by personnel responsible for mission assignments of the group: those competent to contribute to planning did so in spite of a heavy burden imposed by assigned research and development projects which could not be neglected. Thus, there were delays in the assembling of ideas about new facilities into proposals in sufficient detail to serve as the basis for work by the Planning Group. The Planning Group, in turn, had too few people to work with the operating personnel, so could not determine the adequacy of proposed facilities to meet the requirements imposed by the functions to be accomplished.

37. Two important facilities which were badly neglected because of the inadequacy of personnel available to develop proper criteria were Redstone Project R-16, Army Project No. A-373-11, Enclosed Test Range and Redstone Project R-21, Army Project No. A-373-20, Ballistic Track. Each of these facilities was included in the FY 1952 program before sufficient study to determine exactly the type of facility required, and before the economic aspects of construction and operation were determined. To further complicate procedures, an administrative decision was made to construct the Enclosed Test Range (a facility which should logically be designed as a single unit and which may not be operated with construction work in progress) in two increments. The first increment was to cost $547,000, an amount which would tax the ingenuity of the designer to obtain the minimum of structure and utilities required for successful utilization. In December 1951 a contract was negotiated between the Mobile District Engineer and Parsons-Aerojet Corporation to develop design criteria for these facilities. The results of this contract were unsatisfactory to all parties involved.

38. On 15 February 1952, Redstone Project RH-1, The Gorgas Laboratory, the first major project of the FY 1951 construction program was dedicated. It was a high point in the development of the organization to have the first new permanent facility designed for rocket research and development at Redstone Arsenal in operation.

39. In March 1952, Dr George H. Messerly replaced Col Severin R. Beyma as Chief, Technical and Engineering Division. On 28 April 1952, the Technical and Engineering Division was reorganized. The organization chart for this change is included in Appendix B - Exhibit IV.

40. In June 1951 a program was initiated at Cornell University, administration by Cornell Aeronautical Laboratories and Rochester Ordnance District to study causes of rocket dispersion, and the influence of various factors contributing to dispersion. By January 1952 the survey and evaluation of work accomplished in free rocket ballistics and causes of dispersion indicated that ballistic theory for free flight rockets must be further developed, supplemented by numerical analysis, experimental measurements, and review of basic mechanics of rocket flight before prediction of the effect of design and construction variables on accuracy may be determined without prohibitively costly and extensive range work and statistical analysis. A program for study of the motion of spinning rockets was established at North Carolina State College under the direction of Dr. John W. Cell, and a companion program for the study of the motion of fin stabilized rockets was initiated at the University of Tennessee under the direction of Dr. R. R. Newton. The successful experimental verification of adequacy of theory and determination of empirical parameters for numerical analysis is dependent on the development of adequate facilities and techniques for determination of the motion of the rocket outside of the launcher with sufficient precision to permit significant measurements. This requirement plus the urgent need for a facility to rapidly diagnose design inadequancies and construction failure of rockets under development furnished impetus to defend the construction of an adequate Enclosed Test Range at Redstone Arsenal.

41. Additional justification of facilities for FY 52 and FY 53 were presented before representatives of Office, Chief of Ordnance in January 1952; representatives of Chief of Staff in February 1952; representatives of Office, Chief of Ordnance, Chief of Staff G4 and Bureau of the Budget in March 1952. While

this work on FY 52 and FY 53 was going on, additional justifications and criteria including more complete preliminary drawings for FY 54 were being prepared. In June 1952 a meeting was held between representatives of the arsenal, representatives of Chief of Engineers and the Mobile District Engineer to obtain approval of design changes in FY 52 and 53 items.

42. The "Eighth Joint Army-Navy-Air Force Solid Propellant Group Meeting" was held at Redstone Arsenal during 4, 5, and 6 June 1952. The auditorium of Building A-120 was used for the first time for this meeting. In order to be ready for the meeting, this item of the FY 51 construction program was given priority over all other rocket facilities not to be contractor operated. The first session consisted of invited papers on the relationship between current and future weapons needs and current propellant research and development. Another session consisted of invited papers on selected topics in current propellant research and development. The other sessions included contributed papers on propellant chemistry, interior ballistics, and the ballistic applications of solid propellants. Since there were 45 contributed papers, split sessions were held simultaneously at A-120 and the Gorgas Laboratory. Rohm and Haas Company, Redstone Arsenal Research Division was host for this meeting.

43. In June 1952 a method for experimentally determining the motion of a spinning rocket while in the launching tube was devised and construction of the first segmented rail launcher to use this system was initiated. In August 1952 Dr A. C. Menius, Jr. devised a system for verifying the results of this technique by use of radioisotopes. The radioisotope technique has the advantages of positively distinguishing between front and rear bourrelet contacts with the tube and gives an indication of contact pressure but is expensive and would be prohibitive for gathering the statistics required. Both of these methods have been successfully employed and excellent correlation existed between the electrical contact method and the isotope method. The tests using isotopes were not performed until early 1953: fortunately, the correlation was good and the progress made before verification of results expedited the work by at least six months.

44. In June 1952 work on measurement of shock due to ignition of a large jato was started at Radford Arsenal by Test and Evaluation personnel, while Development Laboratory personnel initiated development of an interim igniter to alleviate difficulties and permit continuation of missile tests. Simultaneously

with testing at Radford, test fixtures were designed to permit this type of work at Redstone. While Allegany Ballistics Laboratory solved the ignition problem in time to avoid use of the interim igniter under development here, the acceleration measurements obtained at Radford proved useful.

45. In June 1952 a purchase order was issued to the Reeves Instrument Company for REAC equipment to be used for ballistic computations. The decision was made to install all computing equipment having wide application in the Computation Laboratory of Guided Missile Development Division so there shall be one computations center on the arsenal. Automatic data reduction equipment, including IBM key punch and sorting machines, will be operated by the Data Reduction Section of Test and Evaluation Branch. Programming will be accomplished by the Computations Laboratory.

46. In August 1952, representatives of both GMDD and RTD attended a facility review meeting by Army Chief of Staff G4 to discuss items submitted for inclusion in the FY 1954 MCA budget. These representatives were not permitted to discuss any of these items, but were informed that no item on the FY 54 construction program would be approved before approval of the official Redstone Arsenal Master Plan, which had not been received by Army Chief of Staff G4 through official channels at that time.

47. Failure of higher authorities to release funds to Mobile District Engineer for use on MCA projects for Redstone Arsenal delayed progress on a large group of MCA facilities, the first increment of FY 1952 released being the only items now under construction. The only MCA budget item now in progress for Rocket Development Division is Range Clearing.

48. Occupancy of Computing Laboratory, Building 855 was started in December 1952. Since then all of the FY 51 rocket facilities have been occupied except item ORC 3 and 6 - Temperature Condition and Cycling Building, where installation of refrigeration equipment by York Corporation is nearing completion. Permanent facilities on "Range 1" are being made ready for their first use in flight testing.

D. Organization

1. The basic organization of the Rocket Development Division provides a logical grouping of activities in which

each organizational unit is performing related or similar functions. The line of command is clearly enough defined that each individual should know to whom he reports and each supervisor should recognize his direct responsibilities and know which subordinates report directly to him. The organization is needlessly weak because the necessary formation of units, sections and branches with direct command responsibilities has resulted in some artificial barriers which prevent the maximum utilization of all of the specific knowledge and information possessed by the individual members of the division. To a lesser extent, functions are partially duplicated in individual branches and sections, i.e. Design Branch performing Project Branch functions, sections of Project Branch doing design work. Some minor changes in the organization and operation of the Office of the Chief, Rocket Development Division can alleviate if not eliminate most of these weaknesses.

2. The Chief, Rocket Development Division now controls activities by review. This is because he does not have the organization required to expedite routine matters and screen from routine actions those decisions which set precedents contrary to existing policy or effect new policy. His present organization also lacks the technical support required to evaluate the work of the division and recommend procedures to expedite progress toward completion of objectives, improve quality of technical work, or initiate those changes which will achieve superior results. The organization recommended is needed at division level close to work performance where immediate action can be initiated and results observed. The change in the organization recommended will free the division chief from those routine duties which keep him in his own office, and will permit him to observe the working of his organization, formulate plans, establish policy and adequately represent his division at meetings and conferences with other organizational segments and with his superiors. Direct contact between the division chief and the working personnel is essential though lines of command must be scrupulously observed and instructions or comments regarding procedure or performance of work should be avoided during these contacts.

3. The organizational structure that will free the chief from details is one that provides deputy chiefs (or advisors to, or technical assistants etc., the name is not important) capable of evaluating technical performance of the division in the scientific or engineering aspects of its work,

and an assistant chief (or deputy chief or executive assistant, or office manager, etc) who expedites day to day routine actions, screens correspondence for compliance with policy and good form, coordinates activities between the organizational segments, and through the branch chiefs insures coordination of actions within the branches. In such a structure the administrative office normally reports to the Assistant Chief.

4. The deputy chiefs, who should be selected for broad knowledge of the technology involved in rocket development, must be thoroughly competent in their specific fields and be completely aware of the latest practices and developments in related fields. At least they must be well informed concerning current projects related to rocket research and development. The deputy chiefs, together with the assistant chief, are the staff essential to the division chief. They render impartial evaluations concerning decisions or requests of branch chiefs, They advise the chief concerning their own field of activity. They recommend formulation of new policy or changes in existing policy within the division and advise the chief concerning the affects of policy originated by higher authority.

5. The assistant chief, according to the definition used herein, is the man who acts as chief in the absence of the chief. In this event, the deputies serve as advisors and carry on their routine work without interuption. Hence, the assistant chief must be far more than a routine paper pusher, he must be meticulously careful of details and completely reliable in conducting business in accordance with the policies of the chief. He is the man who makes the organization run smoothly.

6. The deputy chiefs should be consultants to branch chiefs and to individual workers within the organization; however, it should be recognized that they are advisors and are not in the direct chain of command, except when specifically delegated such authority by the division chief and then only to the extent specified by the division chief.

7. Frequent meetings with the branch chiefs individually and at periodically scheduled conferences with all of the branch chiefs, together with frequent informal tours and personal observations of operations should keep the division chief adequately informed concerning current projects. He should be briefed concerning problem areas by the deputy chiefs. Ability or failure to meet schedules together with funding status should be called

to the attention of the division chief by the assistant chief in sufficient time to avoid problems. The assistance rendered to the chief should not cause him to lose direct contact with his branch chiefs who are his responsible supervisors.

8. Training of employees should be a required function at every level of supervision. The individual supervisors should utilize the abilities of the deputy chiefs to increase the knowledge of their subordinates by requesting help in technical problems and should participate in this type of activity together with their subordinates wherever possible. They should aid their subordinates in planning and organizing their tasks and assist in developing better methods of attack for solution of problems. They should continuously recommend sources for increased knowledge and use every method possible to develop the ability of those under their supervision. They should insure development at all levels of the organization by adding responsibilities at a rate commensurate with the increase in knowledge and capability of the individual to assume responsibility.

9. The Projects Branch being the key to obtaining the maximum benefit from the work of contractors presents a particular challenge. The project engineer is the arsenal's direct contact with the contractor and is the contractor's assistant in making available the knowledge, experience, and assistance of the Ordnance Corps to the contractor. He must be well informed concerning current work in related projects that may be of help in expediting the end objectives of the project or projects assigned to him. The ideal project engineer would be a man who has developed an understanding of the problems of the contractor thru the experience acquired by having himself been directly responsible for the conduct of a similar program which was successfully completed. However, such people are rarely available for assignment as project engineers. Further, men successful in design, research or test activities generally prefer direct performance or direct supervision of work to the vicarious participation essential to the technical supervision of the work of a contractor. The project engineer must also possess a personality which will earn the respect and best efforts of the contractor, attributes which are not essential to a competent individual worker. Thus, while the suggestion that the individuals most competent in other branches be assigned projects in their fields of competence is apparently correct, one usually finds that experience in assisting in a contractor's work as a project engineer is more helpful than specific knowledge. Therefore, the best

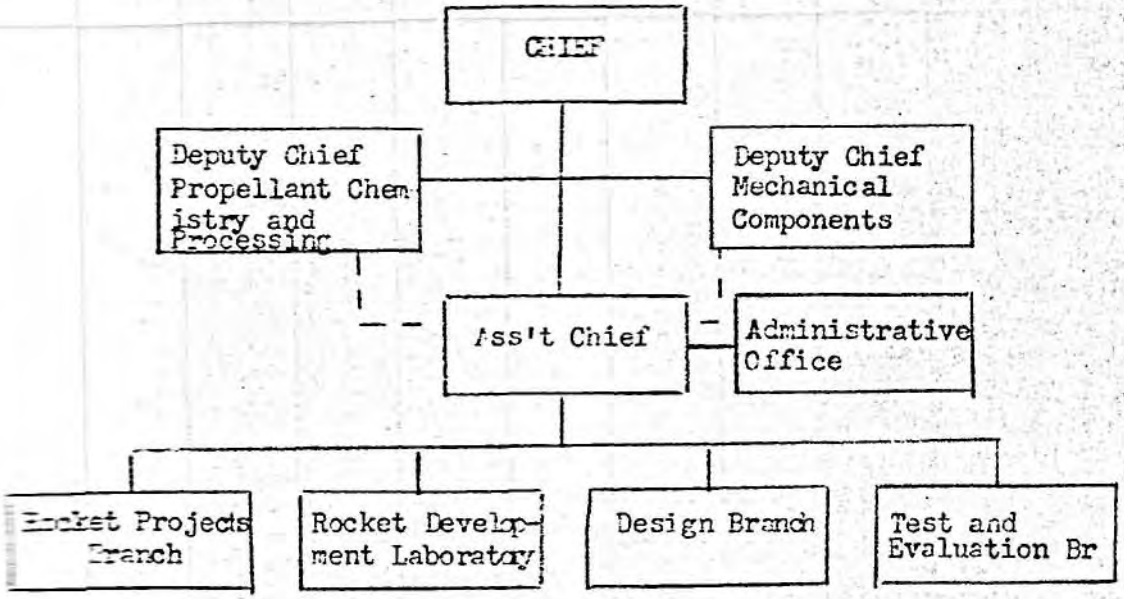
training for a project engineer seems to be apprenticeship to a more experienced successful project engineer. The deterrents to more rapid development of our project engineers seem to be: lack of knowledge of relevant Ordnance Corps policies and procedures, lack of knowledge of the best available sources of information, lack of knowledge of related work in progress at the arsenal or other government establishments, failure to follow reports on related projects, and inability to program, schedule and follow up essential activities. As soon as these difficulties are overcome the ability to anticipate needs and diagnose troubles will develop. It is recommended that on-the-job-training to include review of work in progress at the arsenal and discussion of projects completed and in progress for diagnostic purposes be initiated. It is not recommended that the structure of the Rocket Projects Branch be revised at this time. It is recommended that Chief, Rocket Projects Branch conduct more systematic training of project engineers.

10. The difficulties in the Design Branch and Research Branch are that these segments of the organization are not adequately staffed to perform all necessary functions. Therefore, they are not capable of making a full contribution to the program.

11. The Test and Evaluation Branch should initiate an analysis of operations and procedures. This will result in standardization of many operations, which will lead to simplification of work methods. This study is particularly necessary in range activities and data reduction procedures. A systematic maintenance of equipment program with adequate records of maintenance, unscheduled repairs and alterations of equipment will reduce time and records lost through equipment failures.

12. The proposed organization of the Rocket Development Division, except for the Office of the Chief, is structurally identical to the present organization:

PROPOSED ORGANIZATION OF
ROCKET DEVELOPMENT DIVISION



Since the deputy chiefs review all projects for technical adequacy and suitability of method of attack, they should insure dissemination of pertinent information to the personnel working on projects or problems. It should be their responsibility to prevent performance of an unsuccessful experiment in an identical manner more than once. They should also be well informed of the technical capabilities of all employees of the division to insure that knowledge within the division is utilized before outside help is sought. In this aspect, frequent discussion with and between branch chiefs is helpful and may reveal talents of an employee unknown to his own superior.

E. Facilities

1. Some objective generalities, so fundamental as to be trite, which have been neglected in previous planning have consumed an inordinate amount of time in justification and re-justification, changes and obtaining permission for changes, and selection of site locations and changing of site locations.

First, facilities should be planned to permit completion of functions required by mission assignments. It is senseless to attempt to plan a facility before all of the functions to be accomplished in the facility can be clearly stated. The need for the facility must exist prior to any attempted description. Once having the need, it is simple to list what is expected to be accomplished in or with this particular facility. We are then in a good position to survey existing structures and see if a plan can be formulated which will permit their utilization. Thus, Step 1 of justification is completed.

2. Second, knowing what functions or group of related functions are to be accomplished in this building or with this facility, we can attempt to formulate a plan for accomplishing these functions. This plan will suggest the required equipment and operations. The next step is to sketch a layout of the arrangement of equipment needed and prepare a work flow chart. At this point we have an idea of arrangement with a review to see if all necessary functions have been accomplished to achieve our objective: we are now prepared to study estimated frequency of performing these functions which will indicate need for duplication of equipment or possible provision for expansion at a future date. Third, having a plan for carrying out the functions required and knowing how frequently these functions must be performed in a given unit of time, we can estimate the manpower required. Reviewing the level of skills required for the operations and the background or experience necessary, we can approximate a specification of qualifications for the individuals. Comparing this with our present organization and workload, we can determine what portion of the functions can be achieved with existing manpower, how many additional men may be necessary to conduct the work planned for, what level of qualifications will be required, thus, determining the reasonable expectation of acquiring people to carry out the function.

3. Fourth, a crude line drawing of the facility planned may now be prepared. By considering what utilities are required and what utilities are available, we can prepare ourselves to study possible site locations.

4. The selection of site locations is complicated. First, we must have an area with terrain suitable for constructing our facility. This facility should be conveniently located with respect to other operations required or contributing to its utilization; it should be convenient to those provisions for

necessary services and supporting functions; it should be in a location where exercise of administrative controls are possible; it should not conflict with other activities within the organization or with activities of other organizations; it must be in a location which is assigned to the division or which may be justified for assignment to a division; but above all the location should not interfere with adequate performance of the functions for which the facility is designed.

5. It is relatively obvious that the using organization must feel the need for this facility sufficiently strongly to justify its request. The operating organization should be able to determine exactly what is to be performed in or with the facility and should be able to present a reasonable plan for its utilization. Preliminary arrangement and work flow leading to floor plan should be apparent to the using organization. As soon as this preliminary layout is accomplished and the work plan is known, the Facilities Planning Branch should be contacted and given complete information describing exactly what the user wants and how he expects to accomplish his work with what he is asking for. The other details of the preliminary plan should be worked out cooperatively between the representative of the using organization most completely cognizant of all phases of the operation and the Facilities Planning Branch. Site location should be a joint cooperative venture so the user is able to express his views concerning any factor affecting utility of the proposed construction and while the representative of the planning branch can explain the advantages and disadvantages of desired locations, emphasizing overall plans which may or may not be known to the ultimate user.

6. The first attempt to proceed through all of the logical steps in the design of a rocket facility was before initiation of requests for items to be incorporated in the FY 1954 program. The one exception was the group of facilities, Redstone Project No. R-23, Army Project No. A-373-62 thru A-373-69, inclusive which concerned improvements to certain range areas.

7. It is obvious that the best time to plan for equipping a new facility is when the work plan is formulated. While all details of the equipment cannot be determined at this time, a good enough general idea will evolve to permit more detailed study by those specialists familiar with operation of the particular type of equipment. All installed equipment should be determined as completely as possible before submitting

the facilities request, as installed equipment has a surprisingly large effect on the total cost of the facility and may be difficult to justify unless arrived at by careful study.

8. Following is Ordnance Missile Laboratories Project Priority List dated 22 February 1953 which lists priorities for new construction resulting from a meeting held on 22 February 1953 involving Ordnance Missile Laboratories, Post Engineer, Technical and Engineering Division, Rocket Development Division, Guided Missile Development Division and without concurrence of the resident contractors, Rohm and Haas and Thiokol:

PRIORITY NUMBER	REDSTONE PROJECT NUMBER	ARMY PROJECT NUMBER		TITLE	ESTIMATED COST
1	RH-V	A-373-2	(a)	Crushing & Grinding Facilities	$ 148,291
	RH-VI		(b)	Solventless Extrusion Facilities	461,980
	RH-VII		(c)	Chemical Processing Facil.	167,132
	TH-I		(d)	Laboratory (Thiokol)	206,027
	None		(e)	Security Fencing - All ORC Facilities	36,465
2	TH-7	A-373-24		Addition to Research Lab	314,000
3	None	A-373-3		Modification & Expansion of Facilities	600,000
			(a)	Road Extensions	
			(b)	Pressure Test Building	
			(c)	Combustion Test Stand	
			(d)	Addition to Bldg Nr 412	
			(e)	Connection Between Bldg Nrs 331 & 333	
** 4	OGMC-10	A-373-19		Missile Assembly Shop	1,340,000

PRIORITY NUMBER	REDSTONE PROJECT NUMBER	ARMY PROJECT NUMBER	TITLE	ESTIMATED COST
5	OGMC-1	A-373-5	Guidance Precision Machine Shop	$ 60,000
6	OGMC-13	A-373-26	Guidance & Control Bldg	950,000
7	GM-8	A-373-58	Addition to Guidance & Control Lab	1,137,000
8	GM-9	A-373-59	Addition to Guidance & Control Shop	167,000
9	R-15	A-373-10	Engineering Building	700,000
10	OGMC-3	A-373-7	Measuring Center for Test Area	220,000
11	OGMC-8	A-373-16	R & D Design Bldg	700,000
12	OGMC-14	A-373-28	Addition to Test Area Lab	300,000
13	R-23	A-373-62	Land, Clearing & Grubbing Area	368,000
14	"	A-373-63	Drainage of Area "B"	310,000
15	"	A-373-64	Range Roads, Area "C"	165,000
16	"	A-373-65	Range Storage & Operation Bldg	37,000
17	"	A-373-66	Observation Tower	8,000
18	"	A-373-67	Eight (8) Observation Towers	24,000
19	"	A-373-68	Two (2) Portable Observation Towers	6,000
20	"	A-373-69	Fixed Equip. for Free Flight Range	40,000
21	R-16	A-373-11	Enclosed Test Range	547,000
** 22	OGMC-15	A-373-30	Two (2) Hangars	520,000
23	R-18	A-373-29	Research Laboratory	1,215,000
24	R-21	A-373-20	Ballistic Track	777,000

PRIORITY NUMBER	REDSTONE PROJECT NUMBER	ARMY PROJECT NUMBER	TITLE	ESTIMATED COST
25	OCMC-16	A-373-32	Hangars for Special Vehicles	$ 300,000
26	GM-3	A-373-9	Research & Development Engineering Bldg	1,302,000
27	GM-5	A-373-71	Addition to Propulsion & Fuels Bldg	415,000
28	GM-4	A-373-60	Launching & Handling Bldg	288,000
29	TH-9	A-373-27	Igniter Preparation Bldg	125,000
30	RH-9	A-373-17	Rocket Weapons Develop. Bldg	140,000
31	TH-5	A-373-13	Additional Pilot Facilities	284,000
32	TH-6	A-373-15	Two (2) Static Stands	197,000
33	RH-10	A-373-74	Press Bldg for Solventless Powder Processing Line	60,000
34	"	A-373-73	Control Bldg for Solventless Powder Processing Line	15,000
35	"	A-373-76	Powder Handling Bldg for Solventless Powder Processing Line	39,000
36	"	A-373-75	Oven Bldg for Solventless Powder Processing Line	5,000
37	"	A-373-77	Installed Equipment for Solventless Powder Line	119,000
38	TH-8	A-373-25	Addition to Adm. & Engr Bldg	180,000
39	TH-7	A-373-79	Storage Magazine for Research Lab	3,000
40	R-17	A-373-21	Metal Working Shop	1,150,000

** Equipment has already been procured (cranes)

9. Of the MCA Program FY 52, only OCMC-10, A-373-19 - Missile Assembly Shop and A-373-43 - Barracks are under construction. Changes in criteria, justification of new site location, and changes in preliminary drawings delayed obligating funds on these projects until monies in the program were frozen.

10. Of the list of research and development projects to be included in FY 1955 MCA Program submitted 16 February 1953, Project RA Nr. R-22, Army Nr A-373-105 - Flight Test Stands, $201,000 has been designated Rocket Priority 1; Project RA Nr R-25, Army Nr A-373-101 - Range Instrument Calibration Laboratory, $400,000 has been designated Rocket Priority 2; Project RA Nr R-26, Army Nr A-373-106 - Range Equipment Maintenance Shop - $273,000 has been designated Rocket Priority 3; Project RA Nr R-10, Army Nr A-373-35 - Physical Test Laboratory, $88,000 has been designated Rocket Priority 4. These projects originally presented in the FY 54 submission have been subject of much discussion between Ordnance Missile Laboratories, Post Engineer and Office, Chief of Ordnance.

E. Equipment

1. Equipment should not be ordered until a sufficiently well-known requirement exists to be able to specify precisely what equipment is required. When this type of specification is known, items may be selected from commercial catalogues or Army equipment lists and exact costs determined. Equipment lists should be in continuous preparation and periodically reviewed to discriminate those urgently required, those highly desirable for more economical or more satisfactory performance of functions, and those just desirable to have for occasional use. Continuous preparation of equipment lists will avoid last minute preparation for submission on short notice and will overcome difficulties resulting from justifying desirable items while omitting those actually essential in the rush. Justification of equipment can be on any of the following basis: those essential to perform a specific function required to complete a development; those essential to perform a specific function required to complete a development within a reasonable time; those required to reduce the time and effort consumed in performance of a specific function; and those providing general support resulting in a reduction of overall manpower requirements. Some equipment is required to completely fulfill the function of the Rocket Development Division. Particularly weak is equipment in branches of the sciences of physics. Most essential of this type is equipment for determination of mechanical properties and behavior of materials of construction, including rheology of plastics. It would be ill

advised to include such items on an equipment list before specialists, adequately competent in the fields to plan the necessary operations, are available. It is impossible to order the correct tools without knowing the work to be done and the manner in which this work is to be accomplished. Attempt to list equipment required by the Rocket Development Division will not be made as the only people competent to request equipment are those who must use it.

APPENDIX A - EXHIBIT I

RST 600.1/87
RECORD
HGJones/lm/6427

WAR DEPARTMENT
OFFICE OF THE CHIEF OF ORDNANCE
WASHINGTON, D. C.

CO No. 600.1/1127
ORDTU

23 Jun 1949

SUBJECT: Proposed Construction Program for Rocket Facilities

TO: Commanding Officer
Redstone Arsenal
Huntsville, Alabama

1. An estimate was prepared for inclusion in the ESA budget for the construction of rocket facilities that were considered necessary to determine the rocket research and development work to be carried out at Redstone Arsenal. This program has been included in the 1950 construction budget which is now being considered by Congress. The total estimate is $4,000,000.00, with funds to be supplied as follows:

FY 1950	-	$2,000,000.00
FY 1951	-	1,100,000.00
FY 1952	-	900,000.00

2. To serve as a tentative guide in discussing this program with the Corps of Engineers and in planning the work to be done, the inclosed sheets give the basis on which the estimates were built. Deviations may be allowed as necessary within the limits permitted by funds and legislation.

BY COMMAND OF MAJOR GENERAL HUGHES:

1 Incl. a/n

H. N. TOFTOY
Col, Ord Dept
Assistant

Construction - 1
R & D - 23
Funds - 43

PROPOSED CONSTRUCTION PROGRAM FOR ROCKET FACILITIES AT REDSTONE ARSENAL

FY 1950

Priority	Description	Sq Ft	Est. Cost
1	Modifications to shipping building for conversion to experimental laboratory		$ 50,000.00
2	Modification to (2) buildings for mix room $36,000; roll room $36,000; press room $72,000; inspection room $36,000; and one small test stand $72,000		252,000.00
3	Solid propellant test stands (2) with control building		540,000.00
4	Chemical Laboratory	8,000	320,000.00
5	Temperature conditioning building -80°F to +160°F		450,000.00
6	Flight test range		50,000.00
7	Design and engineering building	8,000	160,000.00
8	Loading and assembly building	1,500	128,000.00
9	Building modification for machine shop area		50,000.00
	Total FY 1950		$2,000,000.00

Incl to Ltr 23 Jun 1949,
RST 600.1/87
00 600.1/1127

APPENDIX A - EXHIBIT I
Page 3

PROPOSED CONSTRUCTION PROGRAM FOR ROCKET FACILITIES AT REDSTONE ARSENAL

FY 1951

Priority	Description	Sq Ft	Est.Cost
1	Building modifications for casting propellant operations (3 buildings w/barricades and sprinkler system) @ $80,000 each		$240,000.00
2	Administration building	8000	160,000.00
3	Liquid propellant test stands w/control building and propellant storage facilities		600,000.00
4	Construction of instrument shop	4000	100,000.00
	Total FY 1951		$1,100,000.00

FY 1952

1	Extension of utilities and service inc. communications and power	200,000.00
2	Process construction of development line and pilot assembly line	450,000.00
3	Construction of batch type N.G. plant	250,000.00
	Total FY 1952	$900,000.00

Incl to Ltr 23 Jun 1949,
RST 600.1/87
OO 600.1/1127

APPENDIX A - EXHIBIT II

Ordnance Department
REDSTONE ARSENAL
Huntsville, Alabama

RESEARCH & DEVELOPMENT FACILITIES PLANNING

PRIORITY TABULATION

Priority No.	Proj or Bldg Identification	Project Description	Preliminary Est Cost
1	RH I	Laboratory, Administration & Engineering Bldg	$ 1,100,000
2	RH II	Solvent Processing Facilities	97,000
3	RH III	Magazines	40,000
4	RH IV	Static Range and Associated Areas	75,000
5	ORC 9	Static Stand A and Instrument Building	245,000
6	ORC 6	Temperature Condition Bldg	206,000
7	ORC 7	Computing Laboratory and Utility Building	309,000
8	ORC 10	Flight Stand	69,000
9	ORC 12	Camera Stand	34,000
10	TH II	Administration & Engineering Building	126,500
11	TH III	Organic Laboratory Relocation	6,000
12	ORC 3	Cycling Building	240,000
13	RH V	Crushing and Grinding Facilities	55,000
14	RH VI	Solventless Extrusion Building	80,000

APPENDIX A - EXHIBIT II
Page 2

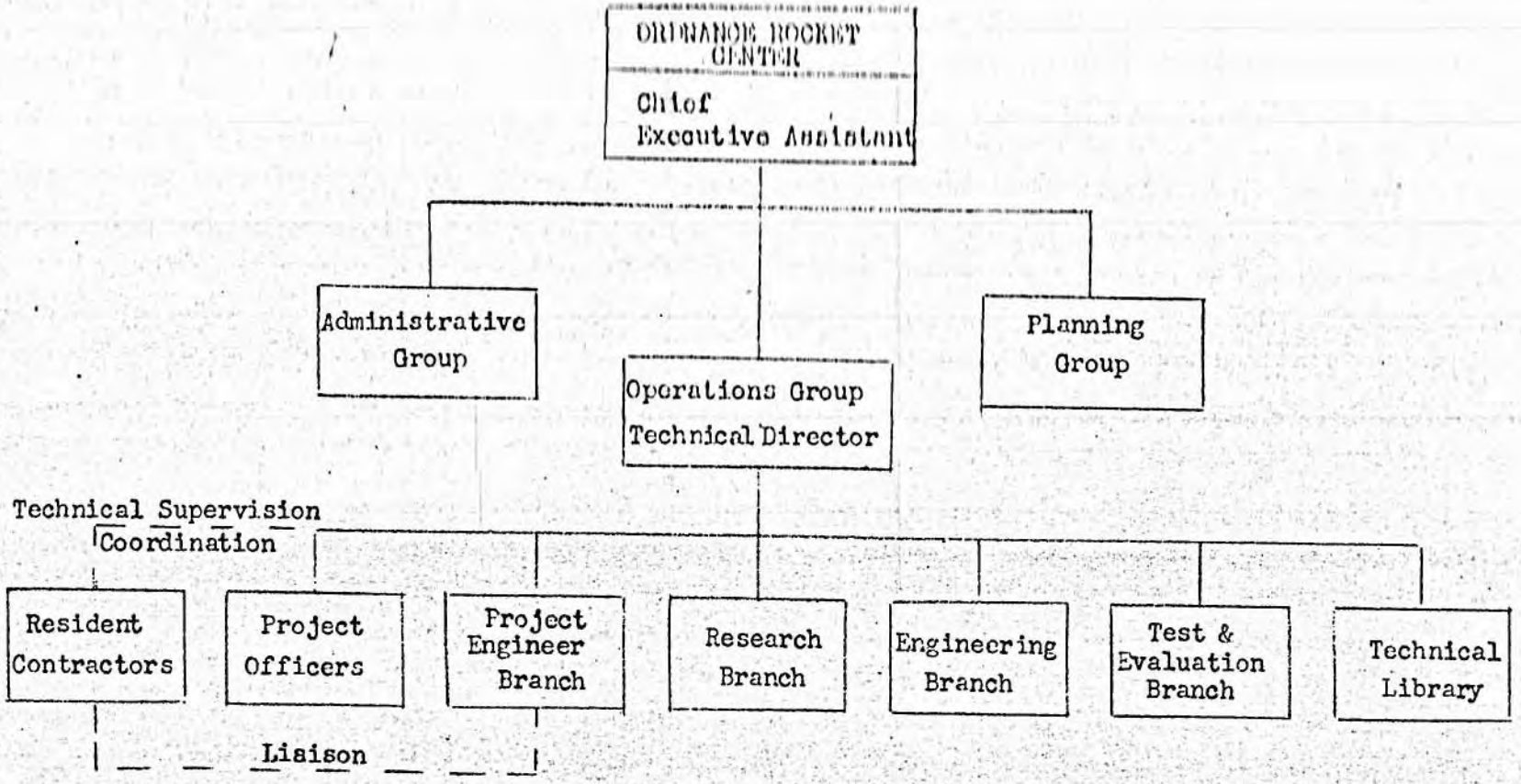
Priority No.	Proj or Bldg Identification	Project Description	Preliminary Est Cost
15	CRC 13	Addition to Laboratory A-120	$ 172,000
16	CRC 14	Propellant Rest House	3,000
17	TH I	Pilot Development Laboratory	112,000
18	EH VII	Chemical Processing Facilities	150,000
19	CRC 1	Solid Propellant Magazine	7,000
20	CRC 2	Igniter Magazine	7,000
21	CRC 4	Assembly Building	206,000
22	CRC 8	Static Stand B	172,000
23	CRC 11	Flight Stand	34,000
24	CRC 5	Liquid Propellant Storage	28,000
25	EH VIII	Development and Pilot Assembly Line	285,000
26	TH IV	Test Stand Facility	5,500
		Sub-total	$ 3,864,000
	CRC 15	*Installed Equipment	186,000
		**Utilities, Roads and Communications	200,000
		Total	$ 4,250,000

*Funds included in Installed Equipment will be expended proportionally with CRC projects.

**Funds included in Utilities, Roads and Communications will be expended proportionally with all projects.

NOTE: Broken line in above list indicates changes in general priority and groups projects that are operationally related.

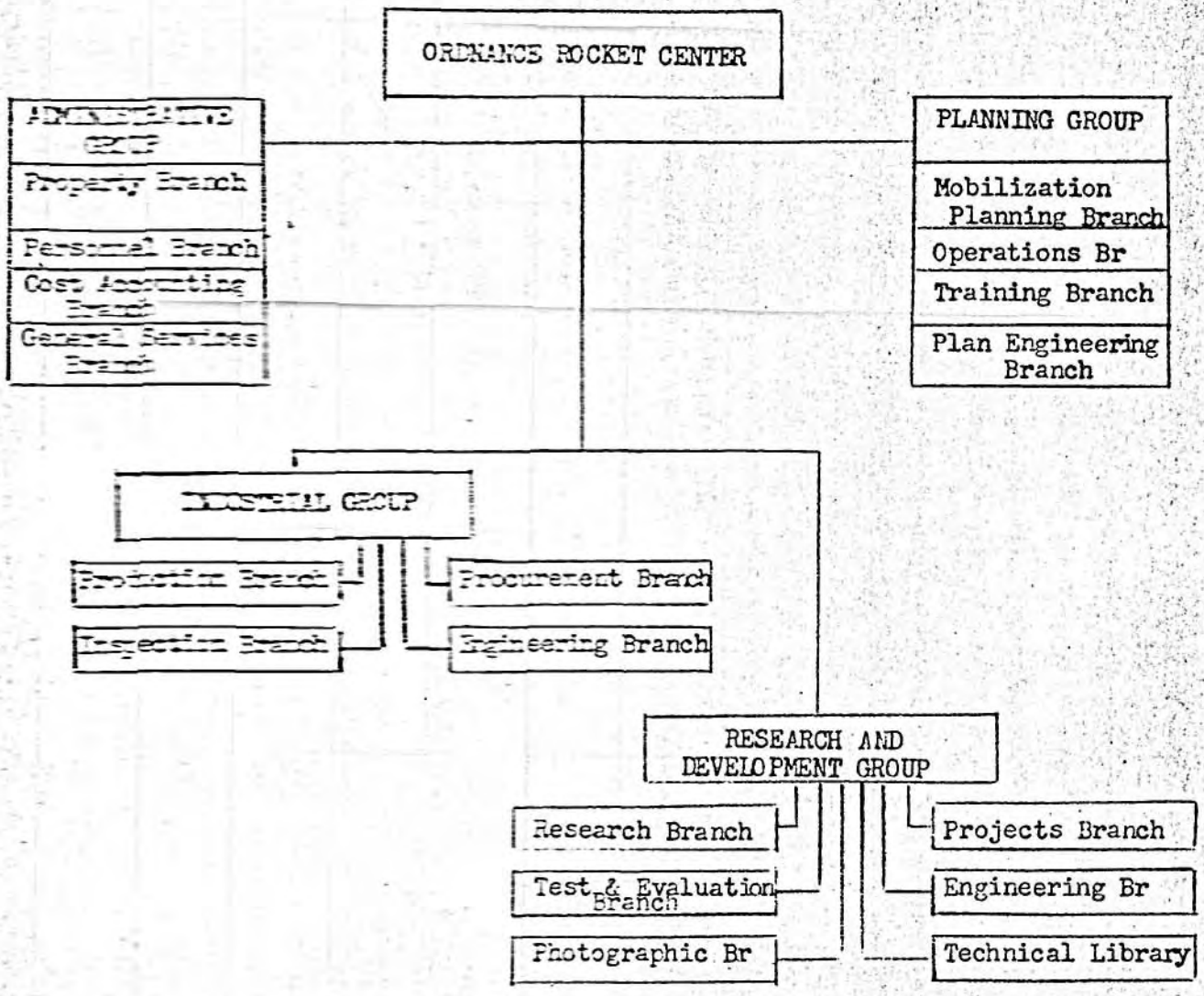
15 March 1950



Organization: 19 January 1951

APPENDIX B
EXHIBIT I

APPENDIX B - EXHIBIT II



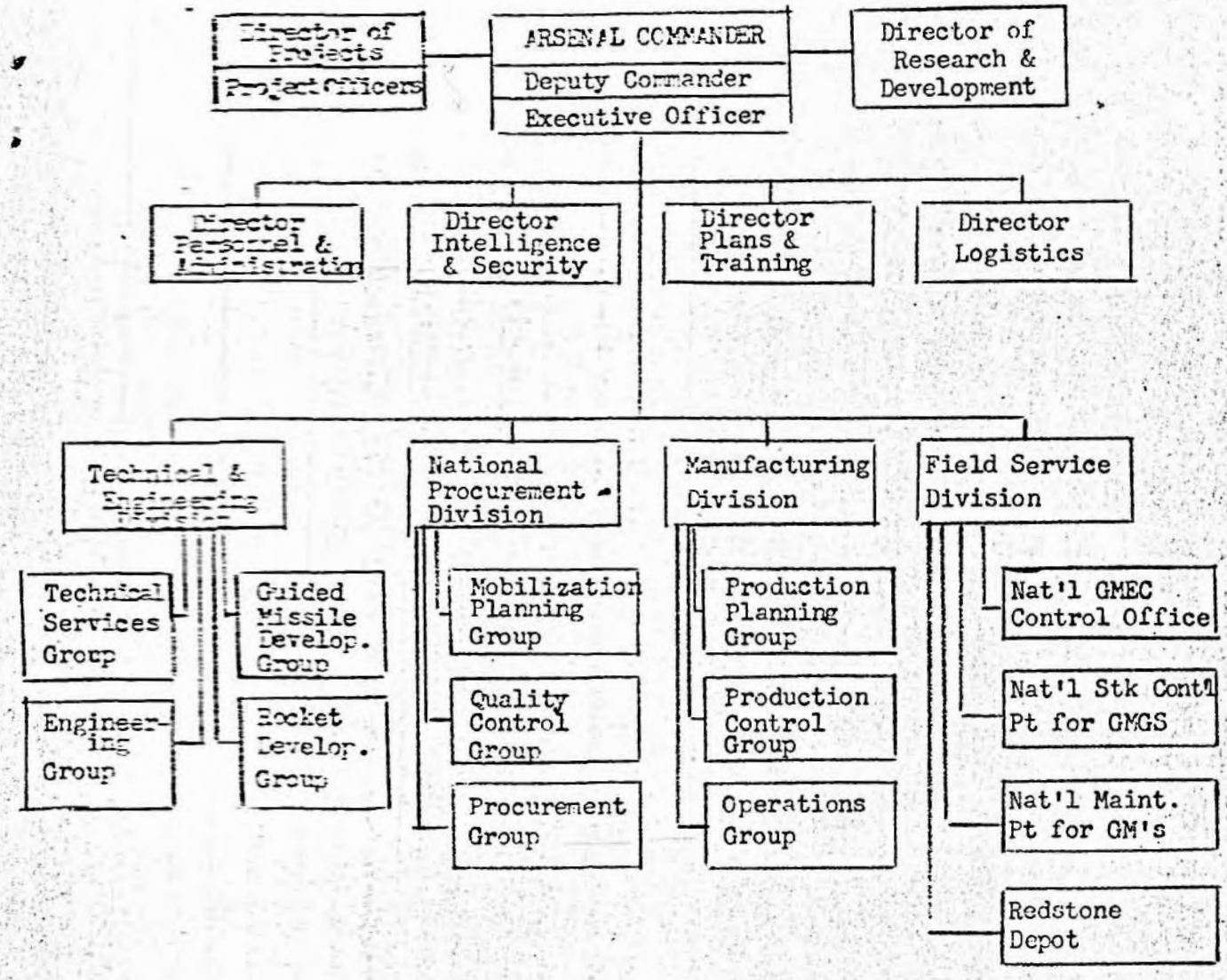
ORGANIZATION OF:

ORDNANCE ROCKET CENTER

20 June 1951

APPENDIX B - EXHIBIT III

REDSTONE ARSENAL



Organization Chart

6 August 1951

APPENDIX B - EXHIBIT IV

[redacted] ORDERS
[redacted] 9

28 April 1952